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# THE POLAR TIMES

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## BLAST-TNG: Tracing Magnetic Fields Across Our Galaxy

The universe is permeated by magnetic fields. And on the Earth's magnetic field can alter the trajectory of charged particles that would otherwise fill our planet, the magnetic field of our galaxy can structure the motion of charged particles along magnetic field lines.

One area where magnetic fields likely play an important physical role is in the process of star formation. Stars form in clouds of mostly molecular gas. Because the clouds are permeated by cosmic rays, some small fraction of the gas particles will be ionized. The presence of this ionized gas means that the gas in these star-forming regions will be coupled to the magnetic field, and if the magnetic field is sufficiently strong it can slow down or stop the gravitational collapse of gas into stars.

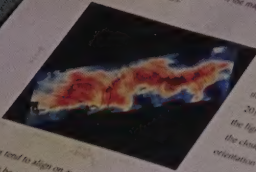


Figure 1. A magnetic field map of the Vela C star-forming region made with BLAST-TNG's predecessor BLASTPol (Fried et al., 2016) observing at 500 microns. The background image shows the light emitted by the dust grains, which shows the structure of the cloud. The "streaks" overlaid on top of the image show the orientation of the magnetic field inferred from BLASTPol data.

BLAST-TNG is designed to make incredibly detailed maps of magnetic fields. It has been known since the 1940s that interstellar dust grains tend to align on average perpendicular to their local magnetic field. The polarization direction of the light they emit can be used to infer the net alignment of the grains. By observing the polarized light emitted by these small particles will be ionized. The presence of this ionized gas means that the gas in these star-forming regions will be coupled to the magnetic field, and if the magnetic field is sufficiently strong it can slow down or stop the gravitational collapse of gas into stars.

While these maps give an incredibly detailed portrait of the magnetic field, they don't directly tell us the magnetic field strength. To understand whether the magnetic field is sufficiently strong to affect the motions of the gas and possibly slow down star formation, we need to compare our observations of the magnetic field to "synthetic maps" of magnetic fields derived from computer simulations of star-forming regions such as the ones shown in Figure 2. In strong field simulations the magnetic field shows considerably more order than in weak magnetic field simulations. Also while in weak magnetic field simulations the cloud density structures align on average parallel to the field, in strong-field simulations the low density features tend to be oriented parallel to the field, while the higher density features tend to be perpendicular to the field.

### WHAT AM I LOOKING AT?

This is an edible 3-D rendering of Vela C – a map of our galaxy's interstellar dust particles which shows the major outcome from BLAST's 2010/2012 long duration balloon launch. (BLAST is back this year with the launch they're launching again any day now!)

### TELL ME MORE.

The 3-D lines illustrate the orientation of our galaxy's magnetic field. The hand-painted overlay is a thermal map between strong magnetic fields which trap molecular gases, increase energy levels, and where we find more of particles – resulting in the origin of our stars!

### WHAT IS THIS MADE OUT OF?

Fondant (sugar clay) and edible paints mixed from food dyes and Everclear, which evaporates quickly to keep the sugar firm. After two days spent building the skeleton, I mixed fondant with water (which dissolves the sugar to make a paste) and "caulk" to seam-seal the magnetic field edges. After it sat for 10 hours, I transported the entire piece in a shuttle THROU hilarious and terrifying process, and then hand-painted the thermal map.

A SUPERGIANT THANK YOU TO BLAST, CSB, Kofie Webster, Danny Gregory, Don Smith, and Laura Cass for the constant creative support and shoutout to Shuttle Joke for navigating us through this gummy transition.

MADE BY: Rose McAdoo (sous chef at LDB)  
SEE MORE ARCTIC SCIENCE CAKES AT: [www.WhiskAndWhiskCakes.com](http://www.WhiskAndWhiskCakes.com)





A lone gentoo penguin, near Port Lockroy, on the Antarctic Peninsula, © Sebastian Copeland

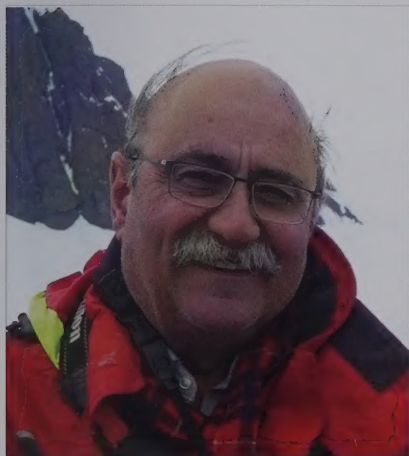
Cover: Science + Art + Dessert! A 3D sugar map of Vela-C's cloud structure and magnetic fields, with a hand-painted overlay of thermal map imaging showing the areas most likely to support future star formation - on display at the McMurdo Alternative Art Gallery.

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# PRESIDENT'S MESSAGE

TO INCREASE AND DIFFUSE KNOWLEDGE  
OF THE POLAR REGIONS,  
TO INSPIRE PEOPLE TO CARE ABOUT  
THE ARCTIC AND ANTARCTIC.  
TO PROTECT THE POLAR UNKNOWN.



DEAR FELLOW AMERICAN POLAR SOCIETY MEMBERS:

As I write, most of the country is freezing, even those parts of the land not typically that cold in winter. I won't engage in a debate over what the climate modelers have been warning us about, namely that such dramatic weather swings are an expected part of global warming trends in the Polar Regions. But I do hope that in the next sessions of Congress policymakers will be motivated to look at related matters.... Hmm: sounds like a source of future articles!

We have had a change of administration in Washington, DC, which I suspect means a return to the standard American approach to the Arctic. The former Secretary of State delivered some rather bellicose statements before the Arctic Council at its last meeting, insinuating a shift in direction away from forty years of peace and cooperation. At the same time, the Russian head of state also rattled his sabers, threatening to build up military stations on Russia's Arctic coast. It was never fully clear who he thought was posing a new threat! By the time the next issue is in the works, we will have a better sense of the Biden team's polar policy direction.

We will announce an annual meeting once the globe returns to normal. Meanwhile, the APS is looking into positioning itself to apply for grants from the National Science Foundation to bolster our role in educating the public about the Polar Regions. We are reaching out to various polar constituencies (science, tourism, technology, etc.) to build membership and share ideas, and are seeking to raise our profile as the voice of polar professionals and enthusiasts.

You will read about these developments in upcoming issues of *The Polar Times*. In this issue, with the spring thaw in mind, we offer the bounty and calm that engaging articles and photos can bring – stories about the nature of ice and living on it, sailing on it, even baking while supporting research on it. So please enjoy our latest issue, and let us know how you are doing. If you have an article you would like to present for publication, our editor, Moki Kokoris, and I would love to hear from you

All the best,  
Ray

**Ray Arnaudo** is a retired diplomat and former Senior Scholar at the American Association for the Advancement of Science, with a career of experience in international environmental and science policy affairs at the State Department. He is currently a member of the National Science Foundation's Polar Affairs Advisory Committee.



# LETTER FROM THE EDITOR



## DEAR READERS:

Polar expeditions, cruises, scientific research, conferences paused, and transport of the newly built Antarctic Vostok Research Station from Russia to the Ice, too. Yes, the virus is mostly to blame. But... as we all know, the spring thaw always comes. And with breakup as it's called in the North, in the territories of fast-frozen rivers, so is there a release of ice floes for the APS in the form of *Polar Times* journal issues – the one in hand, another soon to follow. May with them come a rushing torrent of vitality and the spawning of new interest in 'all things Polar.' Could that be the sound of a reverberating echo of "FINALLY!" that I hear on the winds? (listens) Indeed it is! And we shall make it so!

As I continue to expand my editorial vision for our journal, the plan to add a section for younger audiences (and those who still insist they are young, the silver hairs be damned) has been realized and is being inaugurated herein. In combination with a non sequitur collection of interesting and amusing videos suitable for all ages (yes, you, too), I proudly introduce: (insert sound byte of pomp and circumstance) **bergie bits!**

So, if you have children or grandchildren whom you would like to entice into our fold, now there is content especially for them. But I must forewarn you, the interactive "Iceberger" app kept even me occupied for longer than I am willing to admit. See that? Science really can be fun! And this one works on all devices.

We're also reviving our "Book Reviews" section, with our sincere gratitude to long-time treasured APS member, Jeff Rubin of *Antarctica: A Lonely Planet Travel Survival Kit* fame. Thank you with a hat tip, Jeff, for your contributions!

Our Featured Artist may make it necessary for you to pull out your bibs as your salivary glands go into overdrive! We've heard of the pairing of science and art before, but Rose McAdoo takes that concept to a whole new level. Through the QR code, you may even watch her full presentation, which was part of the "Antarctica: Past and Present" event hosted by the Mystic Seaport Museum last November. Let them eat cake!

But wait! There's more! In my pursuit to broaden our scope of multinational coverage, this issue includes a write-up about the Ice Legacy project launched by Norwegian polar explorer Børge Ousland and French adventurer Vincent Colliard, and an article submitted by Valery Lukin, head of the 56th Russian Antarctic Expedition, about the latest rebirth of Vostok Research Station. The next issue promises to host a wonderful personal story from the medical doctor at Rothera Research Station, replete with his stunning photographs.

Now, if only I could wrestle an article out of a musk ox! Ill-advised. I know.

In the meantime, happy reading!

–Moki Kokoris, Editor

**Enhancement Reminder:** *The Polar Times* is now augmenting its content with QR technology, which offers readers with QR-code reader apps on their "smart" devices a way to view videos and listen to interviews or music relevant to the article. For anyone who does not yet have the app, go to i-nigma and download it. It's free! URL: <http://www.i-nigma.com/downloadinigmareader.html> Then launch the app on your mobile device, point the camera at any of the black-&-white QR-code squares, and voila! The video will play or additional supplemental article/s and websites will appear!



## AMERICAN POLAR SOCIETY

The American Polar Society was founded on November 29, 1934, to band together all persons interested in polar exploration. Members are entitled to receive *The Polar Times* twice a year. The American Polar Society is classified as a tax exempt organization under Sec 501(C)3 of the IRS Code.

For more information about the American Polar Society, contact us at: [americanpolar1@gmail.com](mailto:americanpolar1@gmail.com).

### FOUNDER

August Howard

### PRESIDENT

Ray Arnaudo

### VICE PRESIDENT

Sheldon Bart

### SECRETARY

[americanpolar1@gmail.com](mailto:americanpolar1@gmail.com)

### INTERIM MEMBERSHIP CHAIR

George Blaisdell

[americanpolar1societymembership@gmail.com](mailto:americanpolar1societymembership@gmail.com)

### MANAGER OF CORPORATE RELATIONS & OUTREACH

Robert Breyer

### TREASURER

Stephen Floyd

[americanaccounting@hotmail.com](mailto:americanaccounting@hotmail.com)

### GOVERNORS

Ray Arnaudo • Sheldon Bart • Robert Breyer • Lawson Brigham • Patty Elkus • Moki Kokoris • Merlyn Paine • Dr. Michele E. Raney, MD • Mead Treadwell

### EMERITUS GOVERNORS

Richard Chappell, PhD • Sylvia Earle • David Elliott, PhD • Lynn Everett • Robert Flint • Elaine Hood • Charles Lagerbom • Will Steger

Send contributions to: Stephen Floyd

[americanaccounting@hotmail.com](mailto:americanaccounting@hotmail.com)

For membership inquiries, contact: George Blaisdell

[americanpolar1societymembership@gmail.com](mailto:americanpolar1societymembership@gmail.com)

## THE POLAR TIMES

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### EDITOR

Moki Kokoris, [moki.kokoris@gmail.com](mailto:moki.kokoris@gmail.com)

### ART DIRECTOR

Mary McBride

### CONTRIBUTING EDITORS

Sebastian Copeland

Tara Kramer

Valery V. Lukin

Scott Ressler

Jeff Rubin

With special thanks to:

Carol Barrett





A quiet night in Otto Fjord at the northern end of Ellesmere Island in the Canadian Arctic  
© Sebastian Copeland.

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## "THE LAST ICE"



A dogsled rides over sea ice near Qaanaaq, Greenland.



by Scott Ressler

"THE LAST ICE" is a documentary that grew from the seed of a single fact. Projections show that by 2040, the last remaining summer sea ice in the Arctic will cling to an area between Nunavut in Canada and northwest Greenland. When we started filming in 2015, we knew

that ice-dependent wildlife was already migrating toward this area, creating what some were calling a "Serengeti" of the North. We also knew that the receding ice was creating unprecedented opportunity for international profit across industry and government. More importantly, we understood that at the center of these intersecting dynamics lived over 100,000 Inuit in Nunavut and Greenland whose future was anything but certain.

At its heart, *The Last Ice* is a conservation story. As a filmmaker, I've spent over a decade with National Geographic and the past seven years with National Geographic Pristine Seas, a project dedicated to preserving the last wild places in the ocean. It's been an incredibly rewarding team to be a part of, thanks in no small part to the extraordinary results – 30 scientific expeditions that have facilitated the creation of 23 protected areas that cover a total of 6.5 million square kilometers.

For each such place, we create a short film intended to inspire leaders into action – by showing them the natural

beauty and splendor both above and below the water so that they might be compelled toward protecting it; the emotional yin to our scientists' logical yang. Underscoring our film work has always been the core belief that if one truly relates to a place and falls in love with it, then that person will want to protect it.

Through our films, we invite the viewer to see the natural world as something we are a part of, and not apart from.

And so, as we began *The Last Ice* earnestly, we knew the story we needed to tell in the Arctic – one encompassing multiple nation states, stakeholders, and perspectives – would require something bigger, namely a feature-length film that would create a deep and comprehensive understanding of the Arctic beyond headlines and disconnected images. This would be our most ambitious documentary to date.

In June of 2015, our small film crew flew from Washington, D.C. to Ottawa, making the obligatory overnight before heading



north to Iqaluit. From Iqaluit, we would be traveling by small commercial planes north to Mittimatalik, then on a single-engine Otter to our campsite on Lancaster Sound. There we would stay for six weeks, filming as the sea ice broke up in its annual cycle, a natural process that promised to bring all manner of wildlife, from polar bear to narwhal, directly in front of our waiting lenses.

But presently, in the dining room of the small airport hotel in Ottawa, I found myself sitting near a man who had just returned from a tourist excursion in Nunavut, drunkenly bragging to anyone who would listen (and from the volume of his voice, also to those who wouldn't) about his intrepid exploits. He talked about "braving the unknown wilds" and "conquering the Arctic." Still in his parka, he was hunched over the bar with a beer in one hand and his phone in the other, trying to get his bar-mates to look at his photos and understand just how bold and adventurous he was for having taken part in a paid tour, guided by Inuit every step of the way.

While he might have seemed comically out of place in the 21st century, the fact remains that descriptive parlance referencing the Arctic and expeditions in use today

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*Projections show that by 2040, the last remaining summer sea ice in the Arctic will cling to an area between Nunavut in Canada and northwest Greenland. When we started filming in 2015, we knew that ice-dependent wildlife was already migrating toward this area, creating what some were calling a "Serengeti" of the North. We also knew that the receding ice was creating unprecedented opportunity for international profit across industry and government. More importantly, we understood that at the center of these intersecting dynamics lived over 100,000 Inuit in Nunavut and Greenland whose future was anything but certain.*

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is still the same as it was in the 19<sup>th</sup> century, "Another world." "The ends of the Earth." "A magical realm beyond the reaches of the average man or woman."

In our weeks of filming wildlife along Navy Board Inlet, we *did* feel that proverbial magic. Wake-ups at 4:00am to film a wandering polar bear. Sitting on the floe edge for hours in the hopes of a payoff, and finally rewarded with pods of narwhal dozens strong. Making slow, dancing approaches toward a basking seal, using our body language to convey "don't mind us, we're just looking for some great footage."

And there, in our small camp, with limited communication with the outside world and the privilege of experiencing the natural splendor of the 24-hour-long sun-filled days, we were transformed. It *did* feel a

world apart – uninterrupted views – save for the occasional iceberg or drifting sea ice. For us outsiders, it seemed unreal. I would stare over the ice in awe, imagining how many Manhattans could fit into the landscape I was fortunate enough to find myself in. It was, in a word, spellbinding.

But these romantic sentiments can be as detrimental to protection efforts as they can be clarion calls. When we see the Arctic as part of another world, when we see it as endless in scale, when we see it as, well, *magical* – that can obscure the fact that it is very much a part of our living, breathing planet. In our years of conservation work with Pristine Seas, we know how important

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*Inuit hunter Aleqatsiaq Peary looks out over sea ice near Qaanaaq, Greenland.*

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it is to show the full picture; to connect the invisible dots between the often hidden natural world and the communities that depend on them; whether they are local or global.

Over the five years of filming *The Last Ice*, we came to see a different side of the Arctic that is all too often eclipsed. The reality is that for every tragic image of an emaciated polar bear or disturbing scientific report, there are thousands of Inuit who are living with the effects of a changing climate on a daily basis. It was clear that if there was ever going to be lasting protection of the Arctic, it would be imperative for the outside world to understand the present moment in the proper context, and to view it from the perspective of the people who live there, and who have the most to lose.

It was this new understanding of the Arctic that would become the foundation of *The Last Ice*. One gleaned as much from trips to the grocery store in Igloolik, and doctors visits in Nuuk, as from cold nights on the ice waiting for belugas to appear.

*Inuit youth advocate Maatalii Okalik stands on a beach in Narsaq, Greenland.*



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The colonial history of the Arctic is shocking. In Nunavut alone, the list of transgressions is stunning: Inuit families relocated to unfamiliar locations for the sake of sovereignty; a self-reliant culture accustomed to seasonal encampments forced into settlements and into a capitalistic paycheck system; people issued dog tags with numbers as identification by outsiders who couldn't be bothered to learn names; sled dogs slaughtered without explanation; children taken from their communities to residential schools in the South, under the pretense of needing to be "civilized." In these remote schools, far from their families and homes, children were forbidden to speak their native language or practice their cultural traditions. In many instances, they endured abuses of all kinds.

These transgressions irreparably impacted the past few generations, but it is

the present day Inuit who are living with the consequences: food insecurity; suicide rates among the highest in the world; housing crises. All lines of explanation point directly to those colonial policies.

Today, climate change is the newest specter looming on the horizon for this generation of Inuit. They are the ones who will be living in a very different Arctic in 2040, the ones whose grandchildren will be hearing stories about how the ice *used* to be.

As the sea ice recedes and previously inaccessible resources broadcast the siren song of incalculable profit to the world, Inuit are still not the first to come to mind when the international community discusses Arctic issues. Given what is at stake for them, the moral imperative is for the world to follow *their* lead and prioritize *their* knowledge. Consequently, after the mining, the oil, the fishing, the shipping, and all other newly





possible industries have taken their fill and spread their profits around the world, it is the Inuit, again, who would be left to live with the long-lasting and potentially permanent environmental and societal consequences.

Inuit have not just survived but *thrived* in the Arctic for centuries. If we want a sustainable and healthy environment, abundant wildlife, and abiding respect for nature to be the future for their part of the world, we would do well to balance our romantic views of the Arctic with the very real and immediate views, desires, and needs of Inuit. They are, after all, the experts.

In *The Last Ice*, we follow two members of this very generation who stand at the crossroads of the moment in time where colonialism is giving way to climate change, and a new round of outside interest in their territorial homeland. Maatalii Okalik, an Inuit advocate in Nunavut, and Aleqatsiaq Peary, a hunter in the far north of Greenland, are each learning traditional skills at a late age and in a changing environment.

In many ways they are similar; both were born in the Arctic but spent their formative years elsewhere; Maatalii in Ottawa, Aleqatsiaq in Denmark. Both are now trying to reconcile their modern lives with a culture they grew up distanced from. As the film unfolds, we find they are facing both immediate challenges with the disappearing ice as well as less tangible ones with cultural identity.

Between their respective homes lies Piki-  
alasorsuaq, the largest Arctic polynya and most biologically productive region north of the Arctic Circle. As Maatalii attempts to reconcile the legacy of colonial policies on her community and her own identity, and Aleqatsiaq learns to hunt from his uncle as his own health declines, Piki-  
alasorsuaq becomes a symbol of hope for what the “new” Arctic can be. Here, Inuit from both Nunavut and Greenland are proposing a co-managed area, one that could hold the outside world at bay, allowing Inuit to sustainably manage their own resources as they had done since time immemorial.

Three commissioners, Okalik Egeesiak, Kuupik Kleist, and Eva Aariak traveled to

communities across Nunavut and Greenland to hear *directly* from the people who would be most affected by a lack of protection. It became evident to them that Piki-  
alasorsuaq is a bright spot among doomsday stories, not only for the positive environmental benefits its preservation could bring to the area, but also for its prospect of becoming a model for the rest of the world.

Beyond the scope of headlines and policies and profits through which the outside world views the Arctic, it is all too easy to forget that the story of the Arctic is one about its people.

*The Last Ice* endeavors to leave the audience with a new view of the Arctic – one in which Maatalii and Aleqatsiaq have a brighter future despite the receding ice, not because the ice might return, but because we might have gained new understanding – that rather than empty landscapes, we might first call Inuit communities to mind when thinking about the Arctic; that we might think of the hunter teaching his grandson as much as we think of the explorer trekking the expanse; and that above all else, we might prioritize the Inuit view of what the Arctic could become.

**Scott Ressler (Director/Producer)** Ressler is no stranger to environmental stories and causes, having worked as a producer, director, cameraman and editor for the National Geographic Society for over a decade. He has created multiple documentaries on ocean conservation as a documentary producer for *Pristine Seas*, a project that was launched in 2008, to explore and help save the last wild places in the ocean. In Scott Ressler’s first feature-length documentary, *The Last Ice*, we are introduced to two young Inuit who are fighting for their survival in the face of climate change.

**Enric Sala (Executive Producer)** Dr. Enric Sala is a former university professor who saw himself writing the obituary for ocean life, and quit academia to become a full-time conservationist as a National Geographic Explorer-in-Residence. He founded and

leads “Pristine Seas,” a project that combines exploration, research, and media to inspire national leaders to protect the last wild places in the ocean. He has earned numerous honors for his work, including the 2008 World Economic Forum’s Young Global Leader Award, the 2013 Explorers Club Lowell Thomas Award, the 2013 Environmental Media Association Hero Award, the 2016 Russian Geographical Society Award, and the 2018 Heinz Award in Public Policy. He is a Fellow of the Royal Geographical Society.

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### The Nature of Nature

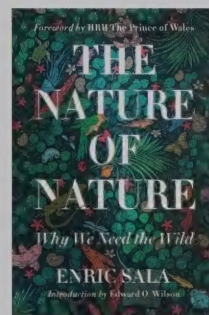
Enric Sala wants to change the world – and in this compelling book, he shows us how. “Once we appreciate how nature works,” he asserts, “we will understand why conservation is economically wise and essential to our survival.”

Here Sala tells the story of his scientific awakening and his transition from aca-

demia to activism – as he puts it, he was tired of writing the obituary for the ocean. His revelations are surprising, sometimes counterintuitive: More sharks signal a healthier ocean; crop diversity, not intensive monoculture farming, is the key to feeding the planet.

Using fascinating examples from his expeditions and those of other scientists, Sala shows the economic wisdom of making room for nature, even as the population becomes more urbanized. In a sober epilogue, he shows how saving nature can save us all, by reversing conditions that led to the coronavirus pandemic and preventing other global catastrophes.

With a foreword from Prince Charles, and an introduction from E. O. Wilson, this powerful book will change the way you think about our world – and about our future.





# SIKU: MIXING HIGH TECH WITH ANCIENT KNOW-HOW

An Inuktitut word for 'sea ice,' SIKU today refers to a revolutionary web platform that provides access to both indigenous traditional knowledge and current-day research compiled by communities living in Canada's Arctic zone. A story that began modestly with a few snapshots of eider ducks struggling for survival on the ice floes of Hudson Bay has evolved into an extraordinary project of fifteen years, which combines ancient knowledge with modern technologies.

by Joel Heath and  
Lucassie Arragutaina

IT WAS COLDER THAN EVER that winter day of 2002, in the Qikiqtaaluk region in Nunavut, Canada. Not far from the community of Sanikiluaq, a group of Inuit with harpoons led the way over the thin, newly formed ice. A team of biologists cautiously and literally followed in their footsteps. The ice fog rising from the open water made the scene particularly dramatic.

*Siku, the Inuktitut word for sea ice, is itself a metaphor of ice as the structure of connectivity and change in the North.*

A large floe edge on the east side of the Belcher Islands had recently frozen over, and a group of eider ducks was struggling to keep the remaining open water from freezing. The opening was critical for them to dive through in order to access the mussels and sea urchins they relied on as food.

The ice edges were littered with carcasses of dead ducks that had frozen into the advancing ice. The Inuit leading the expedition, active hunters from the community – Simeonie Kavik, Elijah Oquaituk and Lucassie Ippak – turned to the biolo-



Puasi Ippak tests out the SIKU mobile app near Sanikiluaq.

gists and said, "This is what we've been telling you about. In the early 1990s, one of our elders noticed that there were as many dead eiders on the ice as there was gravel on the beach." The hunters and elders of Sanikiluaq had alerted the Canadian authorities at the time, but the phenomenon escaped the attention of the scientific community.

As one of the biologists on the 2002 expedition to study the eider die-offs, I had designed an underwater camera that could film the eiders as they dove under the sea ice to forage in winter. I was a Ph.D. student at the time, and spent the next two winters at the edge of the sea ice – under the guidance of Kavik and Oquaituk – collecting footage tracking eider survival methods.

The footage captured was unprecedented. After seven years of working closely with almost all the families in Sanikiluaq, the project resulted in the documentary *People of a Feather* (2011). The film, which went on to win a dozen awards, highlights the community's unique relationship with eiders, and the shared challenges of environmental change that they face.

The Inuit of the Belcher Islands are not just interested in eider ducks – their lives depend on them. While most birds,

including eiders, migrate south, the Hudson Bay eiders remain around the Belcher Islands through the winter. In the absence of caribou here, the community uses eider skins to make traditional parkas, and eider meat is critical to food security year-round.

## Putting together the puzzle pieces

It was in the wake of the film's release that the Arctic Eider Society [AES] was formed in 2011. The groundwork was already well-prepared thanks to the community-driven research programs developed with the support of the Canadian government's International Polar Year (2007–2008) and to their mobilization, dating back to the early 1990s. Around the same time, the Sanikiluaq community launched a programme bringing together twenty-eight Inuit and Cree communities across Hudson Bay and James Bay, to synthesize their knowledge of environmental change. The project resulted in the 1997 publication, *Voices from the Bay*, which to this day remains a definitive source for knowledge on the region.





Elder Jimmy Iqaluit and Hunter Johnny Kurluarok review posts on the SIKU online platform as a part of developing the platform

An Inuit-driven charity, AES aims to empower local people to take charge of research, education and stewardship of their environment. The early programmes focused on assessing changes in oceanography and sea ice – training hunters and youth to use salinity and temperature profilers; establishing time-lapse monitoring stations and carrying out ice-core and water sampling.

The creation of AES's Community-Driven Research Network was given top priority. It includes Sanikiluaq (Nunavut), Inukjuak, Umiujaq, Kuujuaapik (Nunavik region of Quebec) and Chisasibi (Cree community in the Eeyou Marine Region of Quebec). Each of these neighbouring communities held a different piece of the puzzle, and by working together they could finally provide a larger picture of environmental change in the region.

Drawing academic expertise from the University of Manitoba, Carleton University and ArcticNet, as well as funding from the Nunavut General Monitoring Plan [NGMP], the Nunavik Marine Region Wildlife Board [NMRWB] and the Cree Nation of Chisasibi, the network has been able to

develop partnerships. The increased capacity has allowed the tackling of new issues, including the Northern Contaminants Program, and with funding from Polar Knowledge Canada, has facilitated expansion into new regions.

### Three New Priorities:

As capacity continued to grow, the communities identified three new priorities: increasing youth engagement, helping bridge the larger-scale jurisdictional challenges faced by the region, and sharing results and coordination in near-real time.

To involve youth, the network partnered with Kativik Ilisarniliriniq, the Nunavik School Board, to develop a holistic Inuit-centred approach to training and education in the sciences. This has resulted in the Arctic Sea Ice Educational Package. Using interactive multimedia tools, it allows young people to partner with hunters, and to become directly involved in local research.

Regarding the second priority, the first-ever Hudson Bay Summit was held in 2018. It brought together twenty-seven Inuit and Cree communities from James Bay and

Hudson Bay, and representatives of ninety-seven organizations, to form the Hudson Bay Consortium – a forum for collaboration and coordinated stewardship for a region with complex inter-jurisdictional governance.

To address the third priority of sharing data in near-real time, the five communities in the network created a web platform in 2014. A simple base map and corresponding timelines were built, with profiles for community researchers where the results of salinity profiling, ice-core sampling and contaminants-monitoring could be shared online.

Not only did this prototype platform – initially named IK-MAP – prove compelling for data management among so many collaborators, it allowed each community to use its own knowledge systems to interpret data and to see how their results fit into the bigger picture. In the past, the results of research programs would far too often end up in an academic's file cabinet down south, never to be seen again.

Today, the information is accessible to everyone, including tech-savvy Inuit youth. New features have been added, allowing photos and posts to be tagged – not just for individuals, but also for wildlife species and the Inuktitut terminology for ice types, and for measurements, remarks and observations of all kinds.

### Google Street View of the Arctic Sea Ice

In 2015, AES partnered with Google Earth Outreach to develop the first-ever Google Street View of remote sea ice – mapping not only the Sanikiluaq community, but also polynyas and floe edges in winter. The platform provided new ways for northerners and southerners to explore the Arctic sea ice.

The next step was to create a social media network and mapping platform, specifically by and for the Inuit. SIKU: The Inuit Knowledge Wiki and Social Mapping Platform was born, and came to life with new funding after

*In 2015, AES partnered with Google Earth Outreach to develop the first-ever Google Street View of remote sea ice – mapping not only the Sanikiluaq community, but also polynyas and floe edges in winter. The platform provided new ways for northerners and southerners to explore the Arctic sea ice.*





For more information scan this QR code.

Photo: Hunters near Sanikiluaq involved in community-driven research programs

dotal by scientists can be systematically documented and quantified. The data management and permissions approach protection policy means local populations can now be in charge of managing their data and intellectual property, as well as how they choose to share it.

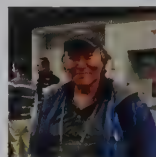
**Joel Heath** – A Canadian scientist and filmmaker, Joel Heath has spent twenty years



in the Arctic with Inuit communities, combining his expertise in ecology, sea ice dynamics and mathematical biology with Inuit knowledge. He

is Executive Director and cofounder of the Arctic Eider Society [AES], an Inuit charity based in Sanikiluaq, Nunavut, Canada.

**Lucassie Arragutainaq** – A cofounder and Board Member of the Arctic Eider Society [AES], Lucassie Arragutainaq (Canada) is Director of the Sanikiluaq Hunters and



Trappers Association. A coauthor of *Voices from the Bay* (1997), he is responsible for many initiatives to mobilize indigenous knowledge.

winning the 2017 Google.org Impact Challenge in Canada. *Siku*, the Inuktitut word for sea ice, is itself a metaphor of ice as the structure of connectivity and change in the North.

The platform has brought together a wide range of tools and services important to the Inuit. Profiles for each community provide local weather, tides and sea ice imagery from multiple satellites in near-real time. It was officially launched in 2019. A mobile app has also been developed to significantly expand the scope of systematically documenting indigenous knowledge and observations.

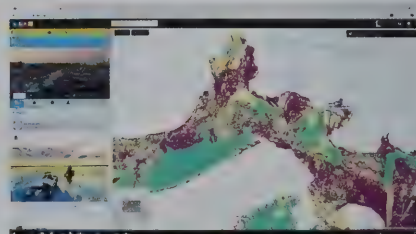
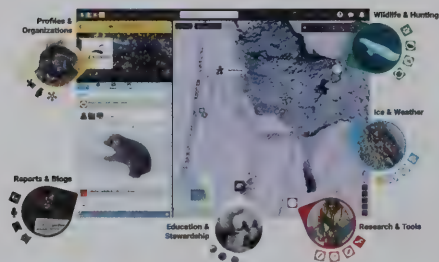
## A New Era

Of course, the mobile app is no replacement for using a harpoon to check the ice or for experiential learning through elders. But

by combining the best of recent scientific approaches and centuries of indigenous knowledge, it is now possible to monitor dangerous sea ice conditions by using Inuktitut terminology to classify types of ice, as an example. It is hoped that this terminology will one day be integrated into machine learning approaches (Artificial Intelligence) enabling indigenous communities to access relevant information remotely – in real time, and in their own language.

Observations that were once typically written off by scientists as anecdotal can be systematically documented and quantified.

Young people can immerse themselves in local culture by sharing hunting stories and traditional place names. Observations that were once typically written off as anecdotal



Left: SIKU online platform showing left-side timeline and right side map windows with various features of the platform highlighted.

Above: SIKU Android App Screenshots.

Above right: SIKU Screenshot showing Ice Roughness product (Green is smooth, yellow medium, purple rough) near Cambridge Bay, Nunavut.





## ON THE RADAR: LIVING WITH POLAR BEARS IN THE ARCTIC



by Tara Kramer

**WHAT IS IT LIKE TO OPEN YOUR FRONT DOOR** and wonder if a polar bear is just around the corner? As the Arctic warms and polar bears spend more time on land, the opportunity for bears to wander into northern communities increasingly puts people and animals at risk.

Polar bears depend on sea ice to hunt their main prey, ringed seals, during the cold months of winter. When the sea ice melts each year, some move ashore to fast until the following fall brings freeze-up once again. But in recent years, the growing effects of climate change have resulted in longer ice-free periods, forcing polar bears to spend more and more time on land. And as sea ice extent decreases at alarming rates, people that live, work, and

*A mother polar bear and her cubs await the return of sea ice along Canada's Western Hudson Bay. Polar bears are spending more time fasting on land due to the impacts of climate change on sea ice extent.  
© Photo by Kt Miller/Polar Bears International.*

study in the North anticipate greater conflict with humans as hungry bears search for new food sources.

In hopes of protecting both polar bears and the communities that share their Arctic home, Polar Bears International, a conservation organization, has been testing a compact surveillance radar system made by SpotterRF® as a bear-detection tool.

"The Spotter system was originally designed for the military, utilities, and major infrastructure projects like airports to detect potential threats over large geographic areas," said BJ Kirschhoffer, Polar Bears International's director of field operations. "Recent applications show that it's also effective in identifying wildlife. It's

lightweight, amazingly sensitive, and able to detect movement in all weather and light scenarios, so we decided to test it with polar bears."

With generous funding provided by Utah's Hogle Zoo, a team of researchers led by Polar Bears International began testing the device in Churchill, Manitoba, Canada to determine if the radar could be used as an early warning system for northern communities. Churchill, located on the shores of Western Hudson Bay, welcomes thousands of tourists each year to witness polar bears gathering to await the return of sea ice. The town also has around 700 year-round residents who share their home and daily lives with polar bears.



Manitoba's Polar Bear Alert, a provincial program, provides people, equipment, and a hotline to manage polar bears that wander into the community. Such programs are rare in the North, and visual patrols also have limitations, particularly in low visibility situations such as whiteout storms and dark nights. With the increased pressures on bears and the large number of tourists, additional safety precautions would mitigate dangerous encounters in towns like Churchill and other communities without the resources for human patrols.

Polar Bears International had previously developed infrastructure in Churchill for the Polar Bear Cam they operate in collaboration with explore.org as well as for their Tundra Connections webcasts, an outreach program that shares live interviews and educational content direct from the tundra. This established presence in the community and the high prevalence of polar bears to be detected by the radar made Churchill an obvious location to test and train the Spotter system.

In fall of 2017, Kirschhoffer and a team from Hogle Zoo headed to Churchill for the initial installation. The SpotterRF was first placed on Churchill's community centre, which includes the school and hospital, and moved seasonally to Cape Churchill and the Tundra Buggy Lodge, a guest facility of Frontiers North Adventures, tour operator and close partner of Polar Bears International. Each location was chosen for its proximity to corridors of high polar bear use and access to established infrastructure, which allowed Polar Bears International staff to monitor the radars from their headquarters in Bozeman, MT.

For the second phase of testing, the team moved the radar system to a year-round location at Cape Churchill in a more remote but nearby part of the Wapusk Wildlife Management Area. These recent developments focus on training the Artificial Intelligence (AI) components of the SpotterRF to differentiate the movement of polar bears from that of other animals such as fox, caribou, and moose.



TOP: A joint team first installed the SpotterRF on the Churchill Town Centre Complex in Manitoba, Canada. © Photo by BJ Kirschhoffer/Polar Bears International. ABOVE: BJ Kirschhoffer, Polar Bears International staff, mounts the surveillance system on the Tundra Buggy Lodge in the Churchill Wildlife Management Area. © Photo by Kt Miller/Polar Bears International.

In order to teach the AI system, staff and research partners monitor the radar, accurately tagging targets as they identify them via remote cameras. When a target appears on the radar's web user interface, Polar Bears International staff can check the surveillance cameras that are cued by the radar to verify what is being detected. Once models have been created for each animal type, filters can be applied to send alerts if a polar bear is detected while ignoring the movement of caribou.

"Once the tool is proven to minimize false positives and false negatives, we can start brainstorming a suite of options such as text messages or flashing lights that would prove to be effective alarms or triggers for

communities and resource managers. Additionally, the tool could also be programmed to automatically deploy deterrents if this was desired," Kirschhoffer said.

While scientists worldwide agree the main threat to polar bears is a loss of sea ice habitat due to climate change, reducing human-bear conflict will ensure that as many polar bears as possible survive in the short term. Utilizing new technologies such as the SpotterRF makes coexistence safer for both people and polar bears, reducing conflict and unnecessary deaths, and safeguarding the future of the Arctic ecosystem for generations to come.

Special thanks to Utah's Hogle Zoo for funding the pilot program and to SpotterRF for continued hardware and technical support. Polar Bears International is also grateful to the Town of Churchill and Parks Canada for their cooperation during the test phase of the project, to Frontiers North Adventures for the use of their lodge and vehicles, and to York University for their partnership in evaluating this tool. To learn more, visit: [polarbearsinternational.org](http://polarbearsinternational.org).

**Tara Kramer** is the operations manager at Polar Bears International and previously spent nine years working in Greenland and Antarctica for the U.S. Polar Programs. She's also a freelance writer and has contributed to *Alpinist*, *Patagonia*, and *The Whitefish Review*.



Polar Bears International's mission is to conserve polar bears and the sea ice they depend on. Through media, science, and advocacy, PBI works to inspire people to care about the Arctic, the threats to its future, and the connection between this remote region and our global climate.





## THE POLAR INSTITUTE

*Since its inception in 2017, the Polar Institute has become a premier forum for discussion and policy analysis of Arctic and Antarctic issues, and is known in Washington, D.C. and elsewhere as the Arctic Public Square. The Institute holistically studies the central policy issues facing these regions – with an emphasis on Arctic governance, climate change, economic development, scientific research, security, and indigenous communities – and communicates trusted analysis to policymakers and other stakeholders.*

The following are transcripts of both the panel presentation statement and closing remarks (excerpted and edited for clarity and space) that were delivered by Captain William Woityra, Commanding Officer of the U.S. Coast Guard Cutter *Polar Star*, during the **Antarctica: U.S. Research and Diplomacy on the Southern Continent** virtual event hosted by the Wilson Center's Polar Institute on November 13, 2020.

**EVENT DESCRIPTION:** The United States is one of 12 original signatories to the Antarctic Treaty and has a long history of interest in the region. This program specifically explored the importance of U.S. research efforts in and around the continent, the unique role of the U.S. Coast Guard in supporting these endeavors, as well as U.S. diplomatic interests and efforts in a time of dynamic change.

**TRANSCRIPT OF STATEMENT:** It's a great honor to be here. Today marks an interesting anniversary: it was actually 43 years ago today that USCGC *Polar Star* set sail from Seattle to go to Antarctica for the first time in November of 1977.

The Coast Guard considers icebreaking and support of the U.S. Antarctic Program [USAP] to be an enduring mission. We've been committed to this since the 1960s when an MOU [memorandum of understanding] with the U.S. Navy transferred the custody and operations of all icebreakers in the U.S. fleet to the Coast Guard. *Polar Star* has been carrying out this mission, and the Coast Guard has been going to Antarctica nearly continuously (with the exception of a few years

about a decade ago) to perform *Operation Deep Freeze* to provide that logistical support, provide icebreaking and sea lift opportunity so that USAP can continue to lead this groundbreaking science.

*Polar Star* was refitted in 2013, and has conducted seven consecutive *Deep Freeze* deployments, which is a record for any ship associated with the Coast Guard. We continue to support the mission every year, providing the support, sea lift, and logistics, and we're committed to continuing this support in the future. To that end, the Coast Guard has allocated \$75 million to provide service life extension projects to *Polar Star*. Starting next summer, we're going to enter a five-year multi-phase contract to ensure that *Polar Star* is able to meet operational commitments in Antarctica for the next decade. Following that, we are going to see a new platform come online.

The Polar Security Cutter is being acquired. The contract was awarded to VT Halter Marine almost two years ago. It's a \$1.9 billion dollar investment that's going to buy three new heavy icebreakers for the Coast Guard, for the United States, so that we can have continued access and year-round presence in the Arctic and Antarctic for another generation. Construction on the Polar Security Cutter will actually start next spring, and will be online and delivered to the Coast Guard by 2024, and operational shortly thereafter. This is truly a state-of-the-art icebreaker. It is worth noting that the requirements for that icebreaker were informed not only by the Arctic, but also

USAP's requirements in the Antarctic, because the Coast Guard is absolutely committed to providing those icebreaking services wherever they are needed for the U.S. Government, worldwide.

We've had a change in plans for our mission, and are demonstrating a bit of operational agility this year. *Polar Star* will be deploying next month to go to the Arctic for what we are calling an Arctic West Winter deployment. This is the first time since 1982, that a Coast Guard icebreaker is going to be north of the Arctic Circle in the winter. This is an opportunity for us to project our national sovereignty in the region, during a time of year that we're not normally up there. We will fulfill the requirements and the lines of effort as laid out in our U.S. Coast Guard Arctic Strategic Outlook.

Specifically, we're enhancing our capabilities, both from a standpoint where we are investing in those next gen platforms (Polar Security Cutters, and possible future Arctic Security Cutters) to provide that presence in the future, and also in our human capital. We're doing training and we're building partnerships so that we will be ready to operate that new fleet of vessels when they come online.

The second line of effort for the Arc-



For an archived video of the full webinar, scan this QR code.





*The Coast Guard Cutter Polar Star cuts through Antarctic ice in the Ross Sea near a large group of seals as the ship's crew creates a navigation channel for supply ships, Jan. 16, 2017. The resupply channel is an essential part of the yearly delivery of essential supplies to the National Science Foundation's McMurdo Station. (U.S. Coast Guard photo by Chief Petty Officer David Mosley)*

tic Strategic Outlook is to strengthen the rules-based order in the Arctic. We're going to go up there and we're going to wave the flag, and we're going to ensure that we are projecting sovereign presence and power into a region that is currently contested.

We're seeing a lot of interesting activity in the Arctic that is noticeably different than we've seen in the past, and the Coast Guard's responsibility to maintain maritime safety, maritime security, and maritime stewardship is no less relevant in the Arctic than it is in any other sovereign U.S. territory. We are doing all of that under an umbrella of national security. The Coast Guard, as a military branch, is going to project that power and sovereignty in the region.

Lastly, the third line of effort from the Arctic Strategic Outlook is to innovate and adapt to promote resilience and prosperity in the region. We are certainly going to do that. We're going to take along some scientists with us who'll be doing applied technology testing of communication systems and other gear to see how they operate in

that region at any time of the year.

So, that's a brief overview of where we are, what we do, and where we're going. I'd love to take some questions from the floor and have the opportunity to respond, and welcome any other interactions with the rest of the panel. Thanks!

**CLOSING REMARKS:** The U.S. is an Arctic nation, and we have Territorial Seas and an Exclusive Economic Zone surrounding Alaska that have been largely neglected for many years because of the Coast Guard's limited capacity and ability to provide presence in that region year-round. This is an opportunity for the United States to pay some attention to that area given the opportunity that we have here, with circumstances in Antarctica not requiring icebreaking services this winter. So, we're going to head north and operate in our Exclusive Economic Zone and Territorial Sea, manifesting that presence on the surface that had been missing for a very long time.

The Coast Guard, at Coast Guard Headquarters in Washington, D.C., as well as at the Pacific Area offices in Alameda, CA

(responsible for the Western Arctic) are very hard at work right now, designing a concept of operations for employment of the Polar Security Cutter once it comes online. We're looking into and examining the different opportunities for what presence looks like and the rotation of vessels. We are also developing and refining the long tail of logistics that will be required to support operations in the Arctic. That's not just the mechanical support, the boats, the helicopters, and the UAVs that will support it, but also the training and the human capital that goes into operating those vessels in that environment. Right now we're at a bit of wasp's waist in terms of Coast Guard and United States polar icebreaking capability. We're down to two icebreakers, the *Healy* and the *Polar Star*. Each poses very challenging maintenance requirements that are keeping us at the dock for many months a year just to keep the ships running. We are investing in sustaining the vessels so that we can be operational and able to respond to those requirements in theater. As a result, there's a very small



cadre of individuals in the Coast Guard that are ready for and familiar with these operations in these regions. So, we're taking steps to ensure that we build a large group of leaders who can respond to that call as we build heavy icebreakers and then potentially medium icebreakers to follow.

We're working under a number of foundational documents and strategies. All the different branches of the Department of Defense are working on or have recently published their own Arctic strategies. Ultimately, the Coast Guard's purpose in the Polar Regions is to fulfill our operational mandates in terms of Safety Security and Stewardship. There's a considerable need for us to demonstrate and exercise that capability, particularly during a difficult time of year. This is a great opportunity for us, not only to practice and exercise our ability to operate, but also to show to the rest of the world that this is important to us and that we are not giving up on Alaska or the Arctic.

I was lucky enough to be part of the inspection team, led by the State Depart-

ment and NSF this year that visited the brand new Chinese station at Inexpressible Island. We saw a new facility that was very much in the growing phase. I can gladly report that we observed nothing untoward, and found no violations of the Antarctic Treaty. The report came out, and I think folks will find some constructive recommendations there. But the core takeaway for us was to see just how new [the station] was. They were expanding and still very much trying to figure things out. There seemed to be a lot of learning and growth going on, but nothing that would indicate any sort of nefarious activities.

I've got 135 hard-working men and women that really put service before self. They come to the ship, and we're away from home, sailing to the ends of the Earth for four or five months a year. And then spending a lot of time in dry dock fixing the ship. You know it's old, and it takes a lot of work to keep this ship running. But our hearts are in it, and we, individually and as a service, are absolutely committed to the U.S. policy goals in the Arctic and the Antarctic.

These are very special places. They're very different, but there are threads that tie them together. And from a Coast Guard perspective, anything that we're able to do in one carries over and has synergies that really inform the other. This is a terrific opportunity for all of the U.S. Government to pay attention, not just to one or the other, but to look for ways that we can make investments that will serve our national interests in both regions.



**Captain Woityra** is the Commanding Officer of U.S. Coast Guard Cutter POLAR STAR, the only heavy icebreaker in the U.S. inventory, and most powerful

non-nuclear icebreaker in the world. He is a career icebreaker sailor with extensive operational experience in the Arctic and Antarctic. He previously managed U.S. ice-breaking policy at Coast Guard Headquarters and completed a Fulbright Scholarship studying icebreakers in Finland.



## ANNOUNCING AN INTERACTIVE EXHIBIT AT THE KATUAQ CULTURAL CENTRE, NUUK, GREENLAND **GREENLAND: EXPLORING ECOTOURISM USING INUIT & INUGHUIT KNOWLEDGE**

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# WHERE SCIENCE IS TRANSFORMED INTO AN ART FORM... WITH CALORIES

by Rose McAdoo

OF MY 85-POUND WEIGHT ALLOTMENT for deployment to Antarctica, 65 pounds of it was cake decorating supplies.

With over a decade's experience as a pastry chef in New York City, Antarctica, East/Central Africa, and Alaska, my work has led me on incredible journeys to make desserts with remote populations in some of the world's most extreme environments.

Between three consecutive seasons at McMurdo Station, I created a series of science-focused cakes that communicate the brilliant research taking place at the bottom of the world. Sugar was used to illustrate a paleontological dig in the Dry Valleys, sculpt chocolate Weddell seals and giant Antarctic sea spiders, fold the fondant magnetic fields of our deep space galaxies, and poured into a handmade mold to replicate a one million-year-old ice core from the Allan Hills. A lone sugar laser beam shot into the Milky Way to count photons in the thermosphere. Sugar sheets shattered into massive ice floes as a tiny edible *Polar Star* icebreaker pushed its way up to the top tier.

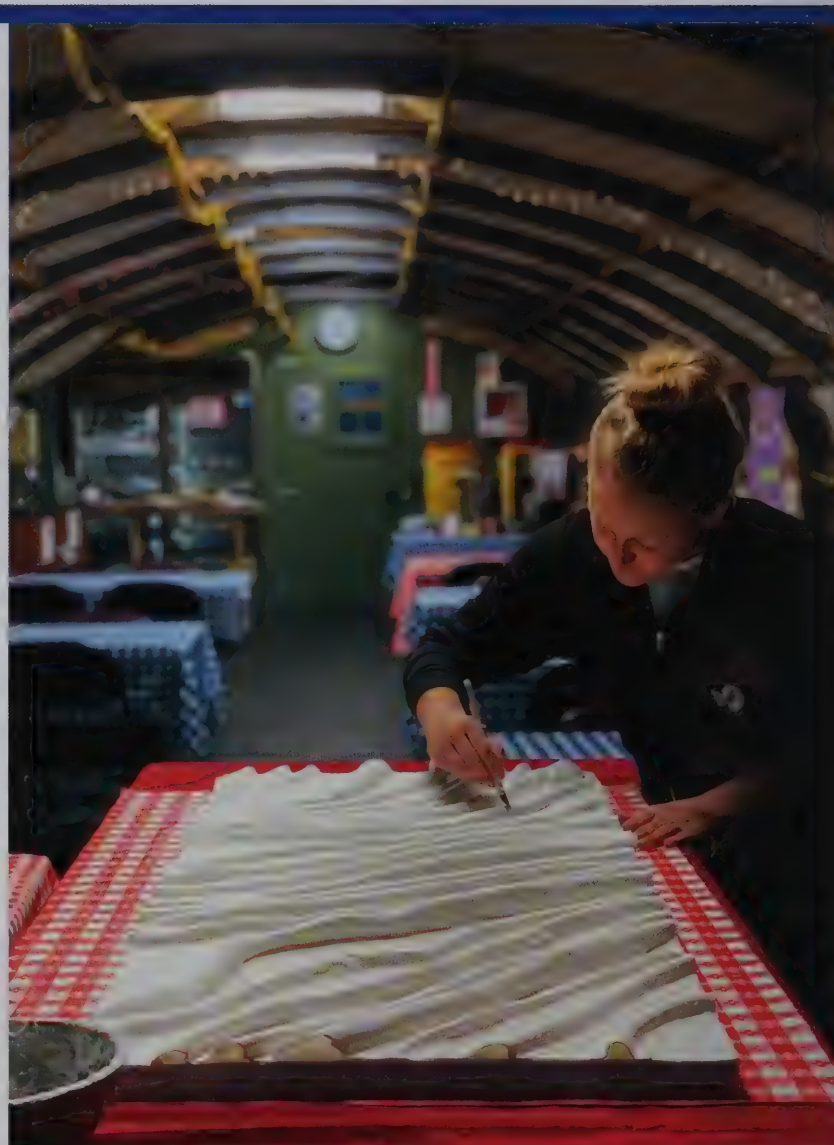
Meanwhile, 10,000 miles north in Alaska, I started "bake-packing" – shoving my pack full of ingredients and tools, and trekking into the wild to craft desserts on glaciers and in rainforests. These on-location sweets highlighted forest fire risk, biological diversity, crevasse breaking patterns, and regrowth at the foot of glacial recession.

I deeply believe in using the excitement and attention around cakes to redirect

conversation into topical issues. I'm also a fierce advocate for the cross-contamination of science and art. Science gives art relevancy and greater meaning, and it drives artistic impact. It's easy to see a graph and respond with a shrug. "Facts are great, but why should I care?" How do you take huge, terrifying topics – climate change, biological extinction, human migration, space exploration – and make them personal? How do you take abstract, complicated research and make it easy to understand? Diversifying your outreach diversifies your audience. It opens minds to new ideas and educates all experts in their respective fields. It encourages play.

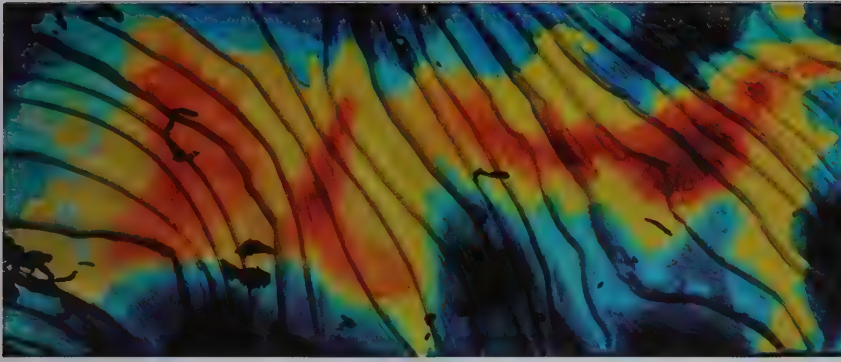
It brings deeper credibility to our work. It clears a new path on which to explore existing ideas. I had the joy of learning this first-hand in the middle of a sunshine-lit night in Antarctica.

At 2:00 a.m., during an overnight balloon launch attempt at our NASA-funded astronomy research camp, I was elbow-deep in fondant, attempting to make a 3D sugar map of our galaxy's interstellar dust particles. The science team's co-principal investigator, Giles Novak, popped into our field tent for a cup of coffee and started excitedly calling out each magnetic field's numerical identification as he recognized them. Around 3:00 a.m., the

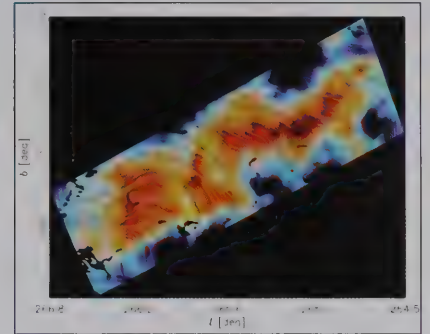


Photos courtesy of Rose McAdoo





LEFT: 3D sugar map of Vela-C's cloud structure and magnetic fields, with a hand-painted overlay of thermal map imaging showing the areas most likely to support future star formation and RIGHT: the data image was captured by the BLAST-TNG science team and digitally rendered by Dr. Laura Fissel



digital image creator herself, Dr. Laura Fissel, had her hands underneath a fold of sugar paste, helping to manipulate a sharper kink at the top of the map to demonstrate the aggressive magnetic pull they had discovered. "It's crazy," she admired. "I've never had someone make art with my science." I beamed. "Well, I've never had a scientist working hands-on to make art with me." She admitted that she had never thought about this image in 3D form – only as a 2D telescopic photograph. "I had no idea what you were talking about, making these magnetic fields as ripples that you can see and touch. And eat!"

Desserts are frivolous. Unnecessary. Easily done without. The same arguments are made about our environment. That is exactly what gives cakes their unparalleled power to communicate the abundance of our Polar Regions and the need to protect them.

Using accessible desserts to communicate overwhelming ideas makes them palatable. We can sugarcoat challenging concepts. We can tangibly consume the invisible. We can make big ideas literally digestible. Science becomes art and art becomes science.

So, I invite you to indulge. Indulge in curiosity. Indulge in knowledge. Indulge in advocacy. Indulge in digging deeper into

every fascinating slice of our Polar Regions. And indulge in sharing your work with the world.

Team members of the BLAST-TNG research project (both scientists and engineers) and the NASA Mission Ops Manager. Photo taken in the MAAG [McMurdo Alternative Art Gallery], the perfect venue for showcasing this delicious piece of scientific art.





## HISTORY BECOMES ART... ART BECOMES HISTORY





An edible replica of Shackleton's Endurance ship being crushed by the ice, just as it had in 1915.  
Photo credit: Stephen Allinger

"To celebrate Midwinter this year, 30 of us transformed our station dining room into the deck of Captain Nathaniel Palmer's Hero, the sloop he captained when first sighting the Antarctic peninsula exactly 200 years earlier. Staying true to Shackleton's early 20th-century rations (because cake interiors need to tell just as much of a story as the outside!), I followed their culinary journal entries, and presented a dark chocolate cake with Shackleton whiskey buttercream and homemade 'expedition biscuit' toasted crumble."  
- Rose McAdoo



Photo credit: Daniel Jennings

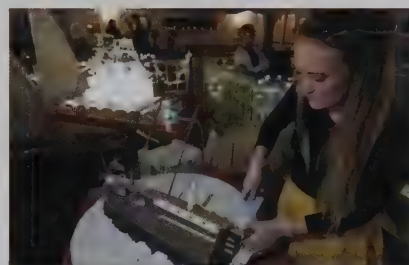


Photo credit: Timothy Wenzel



Courtesy of Rose McAdoo



Courtesy of Rose McAdoo



FROM THE TOP: Tip of the iceberg "Climate Change is Real" cake. Photo credit: Allison Usavage

McAdoo says this cake is an homage to atmospheric scientists who have continuously operated equipment at Arrival Heights for more than 11 years – a full solar cycle. Their team shoots pulsed lasers into the sky to measure density, temperature and wind speed in the uppermost atmosphere, aided by the 24 hours of darkness during the Antarctic winter. Courtesy of Rose McAdoo

Weddell seal bust (on its back is a fondant tracking device which collects information about the circumpolar deepwater – a large, dense under-ice warm water current – and its effects on Antarctica's fragile west ice shelf). Courtesy of Rose McAdoo



Unmolding an isomalt replica of a glacial ice core, complete with ancient air bubbles and striations in snow deposit.



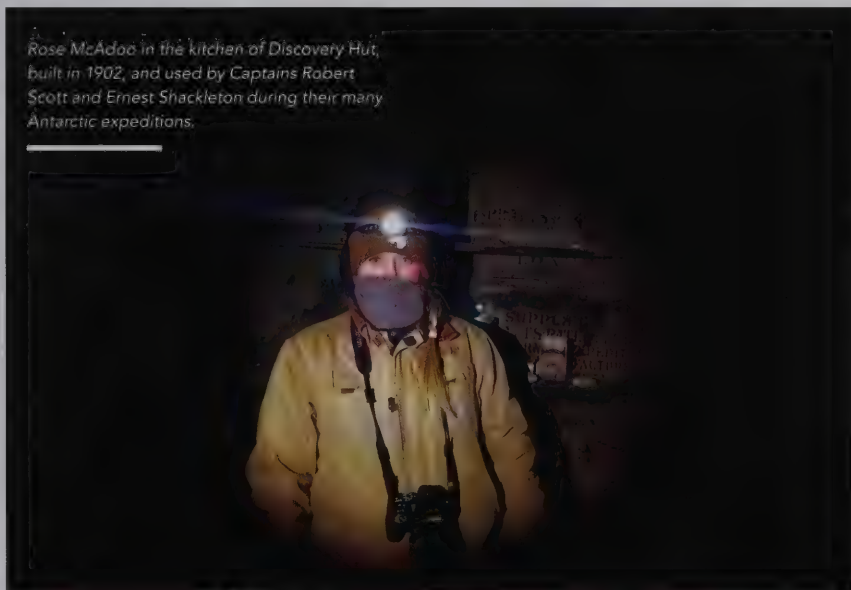
The Polar Star cutter forges through ice up to 21 feet thick. McAdoo says, "This makes it possible for our resupply cargo ship ... to arrive at McMurdo research base with our next one to three years of food, building materials, fuel and vital supplies. Many of us hiked up the ridgelines around base for 10-plus days, eager to see something on the horizon for the first time in months." Courtesy of Rose McAdoo



Scientists have long pondered how Antarctic sea spiders – like the orange sugary confections crawling over this cake – breathe underwater without lungs or gills. Recent research suggests a unique pore structure holds the key. McAdoo first encountered the sea spider at the Crary Science and Engineering Center's touch tank. Courtesy of Rose McAdoo



Rose McAdoo in the kitchen of Discovery Hut, built in 1902, and used by Captains Robert Scott and Ernest Shackleton during their many Antarctic expeditions.



**Rose McAdoo** is an artist, using cake as her medium for building community and raising awareness around global crises. By partnering with global organizations and large arts

affiliates, her unique storytelling work leads her to make cakes with remote populations in some of the world's most extreme environments.

Making dynamic edible art at the intersection of environmental protection, human rights activism, and international development – Rose has cooked and shared stories with tribespeople, subsistence farmers, science researchers, and refugee populations around the world – Haiti, Dominican Republic, Colombia, Argentina, Chile, Rwanda, Kenya, Tanzania, the Democratic Republic of Congo, and most recently in Antarctica.

Rose has been featured as a keynote speaker for multiple World Refugee Day benefits and is a three-time returner on Heritage Radio Network. Her work has been showcased by NPR, *Forbes*, King Arthur Flour, art21, the New Museum, New York Magazine, and Brooklyn Grange Rooftop Farm – and as a gold medalist at the New York Cake Show.



To make your work digestible, visit [www.WhiskMeAwayCakes.com](http://www.WhiskMeAwayCakes.com) and contact Rose McAdoo at [crmcdoo@gmail.com](mailto:crmcdoo@gmail.com).



"AntARTica, Baking and Decorating the Stories of Antarctic Science" presentation by Rose McAdoo at the "Antarctica Past and Present" event hosted by the Mystic Seaport Museum on November 20, 2020.

## THIRD INCARNATION OF VOSTOK STATION



by Valery V. Lukin

**THE ESTABLISHMENT AND MULTI-YEAR SUPPORT** of year-round operation of inland Antarctic stations is an objective, which only the developed-world nations can address. It is not by chance that the USA, Russia, France and Italy have such stations on the Seventh Continent. Even rapidly developing China and ambitiously sighted Chile are currently capable of maintaining only seasonal inland bases in the Antarctic. Japan and Germany closed their seasonal bases after completing their glaciological drilling projects.

Construction and further operation of inland stations requires availability of aircraft and ground transporters, which have a large carrying capacity, a significant radius of activity, and are adapted for transportation of passengers. Additionally, such operations should employ experienced, highly qualified personnel, and be capable of servicing technical facilities in extreme mountainous and low-tempera-

ture conditions. The Antarctic programs operated by the USA, Russia and France have all of these capabilities. While the United States Antarctic Program [USAP] runs the most powerful aviation division, Russia and France possess well-developed transport vehicles for inland sledge caterpillar traverses.

On December 16, 1957, on an Antarctic ice plateau at an altitude of 3488 m, the new Soviet Vostok Station was inaugurated. It had been transported there by means of the sledge-tractor traverse from the onshore Mirny Station, under leadership of Aleksey Tryoshnikov, head of the 2nd Complex Antarctic Expedition of the Academy of Sciences of the Soviet Union.

Vostok Station is situated in the vicinity of the South Geomagnetic Pole, the calculated point at which the Earth's interplanetary magnetic field lines merge. Charged particles (electrojets) of the solar wind rush along these lines to the surface of our planet. It is not surprising that this geomagnetic pole was the focus

*View of the central modules of the new Vostok Station.*

*All photos supplied by the Press Service of the Ministry of Natural Resources of Russia.*

of attention of the scientific community during the International Geophysical Year 1957-1958, and in the years that followed. In addition to observational characteristics of geomagnetism, studies of Earth's ionosphere structure, absorption levels of electromagnetic waves of solar energy and electric field intensity within the surface atmosphere were compiled at Vostok Station. These geophysical studies were extremely important for prediction of "space weather," which has a significant influence on the operation of Earth's satellites, navigation and communication systems, performance of high-voltage power lines and pipeline systems, as well as on the physiology of the human organism. As space nations, the USA and the USSR had shown a significant common interest in these topics. Hence, in 1969, US scientists proposed to equip the geophysical





The recently completed state-of-the-art Vostok Station complex.

laboratory at Vostok Station with the most advanced instruments of the day. Since the installation of the US-produced equipment, all observations were carried out under a joint Soviet-US program.

Vostok Station attracted attention not only from geophysicists. Its mountainous and high-latitude location was also of great interest to meteorologists since it was exactly here that on July 23, 1983, an absolute air temperature minimum on Earth of  $-89.2^{\circ}\text{C}$  had been recorded. The rarefied air above Vostok Station has a mean annual atmospheric pressure of 622.9 mb, and is extremely dry (mean annual absolute air humidity is 0.06 mb). Also of special interest to meteorologists was the fact that Vostok Station was situated near the center of the "ozone hole." Regular observation and collection of total ozone data began in 1976.

In 1970, Soviet specialists initiated a project of deep drilling into the ice sheet at Vostok, with the aim of investigating paleoclimatic changes of the Antarctic. Since 1973, this endeavor had been carried out within the framework of Soviet-French cooperation. In 1989, the USA joined this bilateral project. Soviet experts were responsible for technology and the drilling process, power provision, including delivery of fuel to Vostok and accommodation of project participants at the station. The French provided Freon, cable-rope and scientific equipment for express analysis of collected ice cores at Vostok Station. Americans were responsible for delivery of personnel from New Zealand to Vostok Station via their McMurdo Station, the supply of fresh food products, and transportation of the ice cores for further analysis in France and the USA. The recovered ice cores were distributed equally among all

parties participating in the project.

In 1998, when the depth of the ice borehole at Vostok reached 3623 m, drilling was stopped by directive from the Scientific Committee on Antarctic Research [SCAR], and in 2002, the project participants performed the final division of the ice cores in Arlington, VA. The isotopic analyses of the entire ice core strata determined temporal variability of temperature and concentration of carbon dioxide and methane, which presented climatic fluctuations in 100-kyr (kilo-year) cycles, from glaciation to warming. The Vostok ice core record extended through

*The first structures of Vostok Station, built in 1957, were prefabricated wood-panel houses with thermal insulation. They contained service and living premises. Common block structures were constructed for the drilling complex, mess halls and diesel-electric power stations. Buildings were heated by electricity. Long distance communication with other Antarctic stations and Moscow was handled via shortwave radio.*

four climate cycles, with ice of  $\sim 420$ -kyr. These data were widely published in many renowned monographs on Earth's climate history. Thus, glaciology became a leading discipline within the scope of scientific research performed at Vostok Station.

At the SCAR Conference in Rome in 1994, Russian scientist Andrey Kapitsa gave a presentation about a subglacial lake beneath Vostok Station. The discovery of Lake Vostok was based on the results of generalized seismic sounding data at Vostok Station in 1962, a US-British radar airborne survey of the region, and altimeter data received from the European satellite ERS-1. In 1995, the Russian Antarctic Expedition (PAЭ) began specialized seismic and ground radar studies

of the Lake Vostok area. This work was completed by 2008, and in 2013, its results were summarized and published in The Antarctic Geomorphologic Atlas in St. Petersburg. It was determined that the lake is 250 km long, about 70 km wide, with a water table area of 15.79 thousand  $\text{km}^2$ , an average water layer thickness of 400 m, and a volume of 6100  $\text{km}^3$ . The thickness of the ice sheet beneath which the lake is situated varies from 3530 to 4350 m.

Lake Vostok and associated findings were the final geographical discovery of the 20th century, which attracted enormous attention of the international scientific community. Further study of physical, chemical and biological characteristics of its water layer and bottom sediments made it possible to decipher the geological history of formation of Antarctica and peculiarities of life in the isolated chemotrophic community. The latter fact was inseparably connected with

testing of the methodology of searching for living organisms on other space objects of our Solar System. In the lowest part of the ice sheet, Russian microbiologists found DNA molecules of thermophilic bacteria, which were earlier detected in different geysers and "underwater smokers" in rift faults of the ocean, where the water temperature can exceed  $60^{\circ}\text{C}$ . This discovery became indirect proof of the presence of geothermal activity at the bottom of Lake Vostok. The 5G borehole would be the deepest borehole in history (3769.3 m/12,366 ft) to be drilled through the ice sheet.

From as early as 1967, the specific conditions of human habitation at Vostok Station also started attracting space medicine



*Different angle views of the central station components, including the main entryway.*

scientists, who at that time were beginning to investigate the possibility of long human stays in cosmic space. Impacts of extreme climatic factors on the human body resulted in inevitable changes in its physiological state, and prolonged absolute isolation from the outside world (more than nine continuous months) caused corresponding psychological challenges. The team of polar explorers at the station was comprised of individuals of different ages and social positions, which would significantly broaden statistical estimates of results of these medical studies. More recently, similar studies at the station resumed in connection with preliminary investigation of the conditions of human endurance associated with space expeditions to Mars.

Taking this broad range of interests into account, and despite increased demands on the complex itself, Vostok Station became a principal site of a diverse scope of large-scale scientific research conducted by both Russian and non-Russian scientists.

**Construction history:** The first structures of Vostok Station, built in 1957, were prefabricated wood-panel houses with thermal insulation. They contained service and living premises. Common block structures were constructed for the drilling complex, mess halls and diesel-electric power stations. Buildings were heated by electricity. Long

distance communication with other Antarctic stations and Moscow was handled via short-wave radio. Not far from the station, a snow airstrip was prepared for receiving aircraft equipped with skis. The station included a medical block with pressure chambers for the treatment of diseases caused by hypoxia.

The remodeling of service-living compounds of all Soviet Antarctic stations was initiated in the 1970s. The original wood-panel buildings were replaced by structures made of aluminum panels with mineral insulation, which had been specifically designed and mass-produced in the USSR's Moscow oblast' (province) for settlements in difficult-to-access regions of the Arctic, Siberia, Far East and Soviet Central Asia. Vostok Station was included in this scheme.

Even with their 50-year lifespan, these replacement structures at Vostok Station eventually became obsolete. But, construction of a third new wintering complex would be an exceedingly expensive project. The undertaking was further complicated by the very brief window of time annually during which transport operations in this region and corresponding construction-assembly work in open air are possible. Circumstances changed in 2014, when in late November, the current station was visited by Leonid Mikhelson, Chairman of the Board of Novatek, a large gas-production company, and member

of the supervisory board of the Russian Geographical Society. Known for his patronage of projects in the fields of art and sports, Mikhelson became enthusiastic about the idea of creating a new wintering complex at Vostok Station and decided to support the effort. Work on the technical aspects of the project finally began in earnest in the second part of 2017. Concurrently, legal administrative activity was conducted to arrange the formal transfer of capital construction facilities from the private owner to the state.

On August 14, 2019, the Government of Russia created by its decree a private-federal partnership on the design and construction of this new wintering complex at Vostok Station. Private investor Novatek in this partnership would be responsible for financing the design and construction of the station structures, the purchase of its main equipment (energy engineering, medicine, cook-galley equipment, control means for the state of the technical facilities and fire extinguishing, etc.), purchase of ground transporters, and production of cargo platforms for transportation of the construction components from the onshore base to the construction site at Vostok. The federal budget of Russia would in turn be responsible for financing transportation of the construction structures, transport vehicles and auxiliary equipment,



fuel, and personnel from St. Petersburg to the construction site, of construction-assembly, start-up and adjustment activities at the new wintering complex, as well as the purchase of special scientific equipment.

Production of the components of the new Vostok Station wintering complex was completed at the experimental plant in Gatchina in the Leningradskaya oblast' on August 27, 2020. The modules were assembled into a single complex, and then demonstrated to the client, to top-rank invited persons, and to mass-media representatives.

The complex is a four-story structure with a length of 137.89 m and a width of 12.19 m, made of sandwich-panels with heat-insulating properties that are effective to air temperatures as low as  $-90^{\circ}\text{C}$ . Two main floors are supported by four-meter tall steel columns that are equipped with internal jacks to lift the modules as needed to prevent them from being buried by snow. In the lower premises, there is a depot for the station transporter.

The station is designed to accommodate 35 people: 20 of a year-round team, and 15 seasonal personnel. The living rooms are situated in different station blocks. Members of the wintering group will live in single rooms, while the seasonal team will be accommodated in 2-person rooms. The diesel-power station, equipped with three diesel-generators of 200 kW each, and a reserve power station with one similar diesel-generator, are at different areas of the service building. One additional emergency diesel-power station is situated in a separate isolated space outside the main building. Internal 3000-liter tanks for storage of fuel will be positioned in the main and back-up diesel power stations.

The fuel base of the station will be located at some distance from the station, where it can accommodate 500 ton deliveries of diesel fuel. Operation of the diesel power station and all service premises, including temperature control and the fire alarm system are handled remotely by technicians on duty via ten monitors from a special control room.

The medical block has separate premises for a surgery theater, dentist's room, diag-



Steel support columns equipped with internal jacks to allow the station modules to be lifted as snow beneath them accumulates.

nostic room, X-ray room, areas for physiotherapeutic procedures, a warehouse for medical supplies and expendable medical materials, and a ward for accommodation of people taken ill, as well as a separate area equipped with a special bed for one patient.

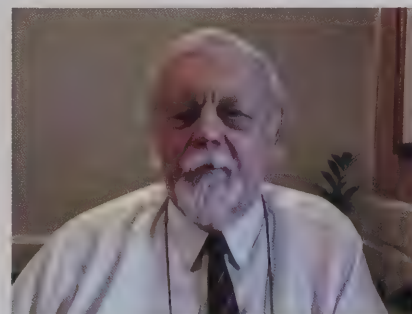
The main building is divided into three sections isolated by fire-proof partitions. In the general block of the station there are a bathhouse/sauna and shower rooms. Water will be fed from the snow-melting tank. A three-level facility for treatment of used water is also planned.

The radio station is equipped with modern satellite instrumentation, and with SW and VHF radio equipment for communication with other Antarctic stations and expedition aircraft.

There are special facilities for six scientific laboratories with their own water and electricity supplies and connectivity with the station's computer network.

Specialized equipment is available to prepare environmentally-responsible waste disposal and transport off the continent.

As of this writing, as reported by *Rossiyskaya Gazeta*, polar scientists and explorers will finally hold a housewarming party at the third and newest Vostok Antarctic Station in 2023.



**Valery V. Lukin** was the Deputy Director of the Arctic and Antarctic Research Institute (AARI) and Head of the Russian Antarctic Expedition in St. Petersburg, Russia from 1991 to 2017. Born in 1946, he graduated from the Leningrad State University, majoring in oceanography, and is the author of more than 300 publications on the issues of polar oceanography, subglacial lakes in Antarctica, history of polar expeditions, and political and legal issues of the Antarctic Treaty System. For the last fifteen years, he has been lecturing and teaching at the St. Petersburg State University.



For more information on the new Soviet Vostok Station

# THE ICE LEGACY PROJECT



## An Ode to Ice and Ambition by Moki Kokoris

THERE IS OFTEN A DEFINING MOMENT in a journey, or a particular set of clarifying experiences that drives an explorer toward an epiphany – an awakening of sorts – which as a consequence shifts the mindset from self-challenge toward a sense of duty to convert passion into broader purpose.

Two men, working as a team, are in the midst of doing just that.

Børge Ousland.

Vincent Colliard.

The former – a world-renowned Norwegian polar explorer, veritable legend, whose accomplishments among many include completing the first unsupported solo crossing of Antarctica, a 1,768-mile journey from one coastline of the continent to the other, and being the first to trek from Arctic Cape (on Severnaya Zemlya) in Russia to the Geographic North Pole – alone, and without resupply.

The latter and younger half of the team – a French polar explorer, versatile adventurer, professional mountain guide, and Mountain Hardwear's Ambassador of Impact, who is just as passionate as he is determined to blend exploration with activism.

But their current joint endeavor isn't about being the best, or the fastest, or the first so much as it is about their ambition to raise awareness about the changes they have respectively and collectively witnessed in a warming world. Both feel a strong obligation to leave a lasting impression on their followers by creating a legacy of influence that is consequential. It is this objective of the Ice Legacy Project that will serve as sustainable inspiration to anyone who generations hence may choose to follow in their followers' boot prints...

IceLegacy's mission is to record the drastic deterioration of the world's twenty largest ice caps by traveling across them. Thus far, Ousland and Colliard have

crossed nine, and expect to execute the rest over the next decade. Of all those completed, the Stikine glacier expedition was the most challenging.

During each of the crossings, Børge and Vincent collect samples of snow and ice that are later delivered to the University of Alaska Anchorage where scientists study the meltwater's isotopes by which they are able to monitor and compare glacial fingerprints. The IceLegacy team also provides ground-level photographs and comprehensive descriptions of the surrounding area and conditions to Airbus Defense and Space, a division of the multinational aerospace corporation Airbus SE, which captures detailed satellite images of the glaciers Ousland and Colliard are crossing at the time.

While traveling across the chosen ice fields, Ousland and Colliard have noticed massive changes in the ice since their past adventures in the same regions.

As appears to be the case all across the Arctic and on many glaciers around



# CROSSING THE 20 LARGEST WORLD GLACIERS

Alpina 1883 GENÈVE

IceLegacy

Believe. preserve, transmit



2014	2018
1. NORTH CORDILLERA RANGE	1. STIKINE ICECAP
2. STIKINE ICECAP	2. STIKINE ICECAP
3. MOUNT EVEREST	3. MOUNT EVEREST
4. MOUNT EVEREST	4. MOUNT EVEREST
5. MOUNT EVEREST	5. MOUNT EVEREST
6. MOUNT EVEREST	6. MOUNT EVEREST
7. MOUNT EVEREST	7. MOUNT EVEREST
8. MOUNT EVEREST	8. MOUNT EVEREST
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10. MOUNT EVEREST	10. MOUNT EVEREST
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12. MOUNT EVEREST	12. MOUNT EVEREST
13. MOUNT EVEREST	13. MOUNT EVEREST
14. MOUNT EVEREST	14. MOUNT EVEREST
15. MOUNT EVEREST	15. MOUNT EVEREST
16. MOUNT EVEREST	16. MOUNT EVEREST
17. MOUNT EVEREST	17. MOUNT EVEREST
18. MOUNT EVEREST	18. MOUNT EVEREST
19. MOUNT EVEREST	19. MOUNT EVEREST
20. MOUNT EVEREST	20. MOUNT EVEREST



Illustration credit: © Julien Tardif

the planet, soot - a black powdery substance consisting largely of carbon - was also heavily present on the Stikine ice field in Alaska. Soot particles, classified as light-absorbing impurities, are responsible for trapping heat on the surface of the glacier, thus accelerating melting, the run-off from which contributes to sea level rise. Understanding these dynamics allows us to better interpret the variables in the cause and effect process.

Scientists are able to date the carbon and determine its origin i.e. ascertain whether it is volcanic debris or residue from anthropogenic activity. Determining the origins of such pollutants could guide

the development of strategies to reduce or prevent their emission. We now know that these particles are a threat not only to Earth's glaciers but also to human health, both directly and indirectly.

As direct in-person and in situ observation is incorporated into scientific data, the information can be conveyed with more clarity and to more sectors of society. Børge's and Vincent's ultimate goal is to provide indisputable evidence through their IceLegacy expeditions, which they hope will spur policymakers and the general public to assertively engage in the cause.

Børge's and Vincent's ultimate goal is to present indisputable proof that even the

largest glaciers are showing rapid deterioration, which should spur policymakers to consider bolder actions that will prevent the most catastrophic consequences.

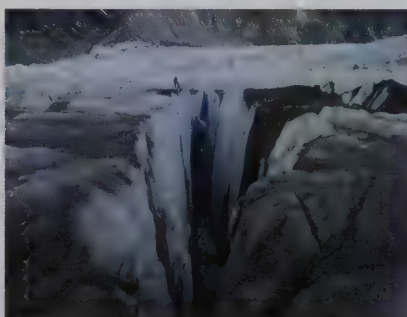


IceLegacy - Main  
Spitsbergen glacier  
expedition, Svalbard



Complete IceLegacy  
Stikine Icefield  
Expedition webpage  
(includes satellite  
imagery, route,  
dispatches and videos)

Below left and middle: The Stikine Icecap (marker #12) straddles the Alaska-British Columbia border in the Alaska Panhandle region. Photo credit: © Børge Ousland  
Børge Ousland and Vincent Colliard crossing the southern Patagonia ice cap carrying gear to the glacier (2013)  
Photo Courtesy of IceLegacy.



## RIDERS OF THE STORM

by Sebastian Copeland

"They're here," I said. Eric was deep in slumber when, surprisingly, he responded with a sleepy voice: "Direction?" "Due North. We're good to go," I replied. It was 0130h. We had shut down early, but I did not manage to sleep before midnight. At the time, it was dead calm, the kind that screams in your ears. Deep on the Antarctic plateau, where life had not existed in at least 25 million years, a windless day can be oppressive, the weight of its silence almost deafening. When your chosen mode of transportation relies on a kite, waiting for wind can feel like dripping water torture, especially when the clock is ticking, as prescribed by the calculus of daily food rations.

To be sure, winds are ubiquitous on Antarctica, but that doesn't mean they're always there, particularly in the austral summer, when the sun's energy heats up the continent, and high-pressure systems can keep air from descending with force as they relentlessly do during the winter. Summers do see their share of winds – especially when topography assists – which are driven by fairly predictable physics, namely: gravity. Cold wind gathers force as it reaches an ice sheet and follows the down-sloping terrain, just like water; and Antarctica's surface is never entirely flat. These winds are called katabatic. And katabatic winds are vital to kite skiing missions. But on that night, the breeze that was gently flapping the sides of the tent was not katabatic. It was a system.

In 24-hour daylight, your body clock adjusts to the conditions: you travel when the winds beckon, and sleep when they falter. We were 128 kilometers from the first stop on our 4,100-kilometer cross-continental mission, a crossing that would cover two poles – of Inaccessibility and the South Pole – before reaching the end



With its foreword by actor and activist Leonardo DiCaprio, you will find photos that chronicle some of the continent's interior landscapes captured during this latest mission, as well as coastal vistas from multiple seasons spent in the southernmost latitudes in Sebastian Copeland's new book *ANTARCTICA: The Waking Giant* (Rizzoli 2020), recipient of the 2020 IPA Book Photography of the Year award. Available where fine books are sold.

of the continental mass on the opposite coast, at Hercules Inlet. This was to be a first, all done without support, using nothing but human and wind energy.

On this Christmas Day, while much of the world gathered around a warm meal, we knew we faced the head of a storm. The many days lost to dead calm stillness left us with little choice but to ride it. By the time we had cooked breakfast, melted ice for water and packed up our tent, the wind was blowing snow and intensifying. The cloud ceiling was low, and the temperature hovered at negative 30 °C, excluding wind-chill. By 0330h, clipped into our 13-meter kites, we took off.

On the ice, an oncoming storm keeps you on edge. Riding the head of one creates a nervous energy that gamblers probably know: the variables keep you alert. The wind came up fast and strong within our first hour. By 0430h, we switched to our smallest kites, the six-meter ones, which shot up like rockets into the sky. The visibility quickly dropped, and within minutes, it was clear that we were riding

the storm. Gusts grew to 40 knots, and the temperature dropped to -65 °C wind-chill. Visibility was down to 40 meters, and we vigilantly kept each other in sight at all times. Getting separated now could be lethal to at least one of us: the one without the tent! Some might even call it unsafe, especially when periodically, speed would flip the sledges after hitting a ridge from a bad angle, and force an abrupt stop while your partner fades into the blowing snow. One hour of tempting fate in such mayhem, and we were done.

We set up the tent while the storm continued to build. Eric started digging an ice cave, just in case. But the drifting snow, and cold, ended the project. Meanwhile, I had brought the stove inside and made some tea as blood returned to my extremities. This was day 52, and I had developed serious frostbite on my right large toe. In perpetual deep freeze, Antarctica's terrain is mostly rough and hard, with shapes, called sastrugi, that follow the dominant winds. In Greenland the previous year, my ski boots had functioned like a charm





Clockwise from top: Stormy weather: new and old icebergs collide near Melchior island, in the Antarctic Peninsula. Approaching the Ellsworth mountain range, at the end of a 2500-mile journey across Antarctica. A bust of Lenin and four feet of chimney is all that remains of the buried 1957 Russian base, at the Pole of Inaccessibility.

during a 2,300-kilometer crossing of that superb ice sheet. On Antarctica, however, my downwind toe got traumatized by the constant pounding in the toe box, suffering the unrelenting assault of these hard sastrugi. Having to ski in one direction for months at a time allows little in the way of recovery, not unlike endlessly edging a ski turn around a mountain by placing pressure mostly on one leg. The trauma resulted in a cold injury, and necrosis began setting in and inching up. But months of preparations and pressures of fundraising, sponsor relations, and blind ambition to succeed had compelled me to forge ahead, pushing me to gamble the risk of losing a digit with close monitoring and adjustments to my gear. That day, the toe was stable. While the storm raged outside, temperature inside the tent temporarily rose to a balmy 12 °C degrees, thanks to the greenhouse effect from the sun's high summer angle. It was 0700h. We hung our clothes to dry and buried ourselves inside our sleeping bags for another long slumber. On this day, we had covered a meager 31.8 kilometers; but we had finally crossed the 1,000-kilometer mark.

Two days later, the weather broke and we closed the gap, reaching the distinctive

marker of the Pole of Inaccessibility [POI]. Sticking up from the rising ice sheet, at 12,220 feet in elevation and at S82°06.696 E055°01.951, is the remaining four feet of a chimney from the buried Russian station that was built there in 1957. Before abandoning the station that same year, a bust of Lenin had been affixed atop the structure. It remains there, frozen and forlorn, and still facing Moscow. We were only the fourth team to reach that point since then, and the first to cross the continent without motorized transportation to reach it.

Eric and I would reach the South Pole, and eventually the continent's western edge one month later, thereby completing the first unassisted east to west transcontinental crossing (via POI), and all on the 100th anniversary of the attainment of the South Pole.



**Sebastian Copeland** is a polar explorer, photographer and climate analyst. In 2017, Copeland was listed as one of the world's top 25 adventurers of the last 25 years. Noted as a photographer "who has produced works that are of outstanding artistic merit, and communicates messages of urgent global significance," Copeland has led numerous expeditions to document the endangered Polar Regions, covering more than 6,000 miles on skis over the ice. Since

2001, he has warned of systemic transformations taking place there and their geo-economic consequences. Copeland has addressed audiences at the United Nations, institutions and governments globally, as well as Fortune 500 companies, speaking about the urgent need for a market shift toward a sustainable economy.

He is a fellow of The Explorers Club, a member of the International Glaciology Society, and a founding member of Artists for Amazonia. His activism efforts for social change earned him a seat on the Board of Directors of the US branch of Mikhail Gorbachev's Green Cross International. And in 2019, Copeland was awarded the National Order of Merit by French President Emmanuel Macron.



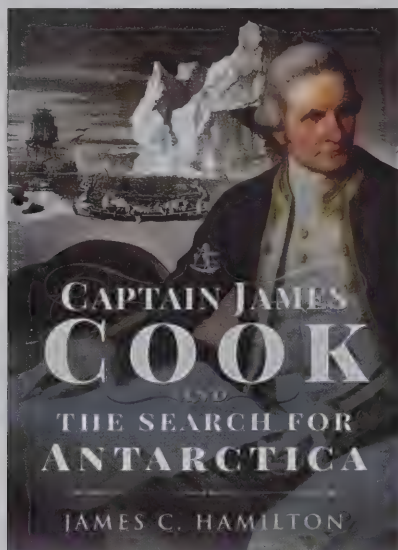
Sebastian Copeland's *Arctica: The Vanishing North* (teNeues 2015), with a preface by Sir Richard Branson.



"FIELD OF VIEW"  
video statement



SEBASTIAN COPELAND  
website



## Captain James Cook and the Search for Antarctica

By James C. Hamilton (Havertown, PA:  
Pen & Sword Books, 2020; 303 pp)

*Reviewed by Jeff Rubin*

The premise of this book by historian and philatelist James C. Hamilton is solid: collate information from Cook's three voyages about his efforts to discover *Terra Australis Incognita*, the Unknown Southern Land supposed, from ancient times onwards, to exist at high austral latitudes.

Cook, history's greatest explorer, completed the first circumnavigation of Antarctica – which he never saw – over portions of three summers. He was first to cross the Antarctic Circle, which he did three times during his second voyage of 1772-1775 in *Resolution* and *Adventure*, spending a total of about 13 days south of the Circle and reaching a furthest south of 71°10' S. On the same voyage, he discovered South Georgia and the South Sandwich Islands. And all this without losing a single crewman.

Still, Cook was unlucky. It's almost more remarkable that he *didn't* discover Antarctica, given that he pushed so much further south than anyone before. But in the longitudes where he did so, the coastline of Antarctica itself also swerved southward.

In sum, Cook's actual "search for Ant-

arctica" does not provide an enormous amount of material for a book, without a great deal of background and a fairly detailed, even minute, examination of his ships' movements. We get both here.

The 16 chapters include "Cook's First Crossing 17 January 1773" (12 pages on crossing the Antarctic Circle), "Separated in an Antarctic Fog 8-11 February 1773" (10 pages on *Resolution* and *Adventure* parting in a thick fog), and "'An agitated & tempestuous sea': the Cook Strait October-December 1773" (16 pages). The Second and Third Crossings of the Antarctic Circle are each also given a chapter of their own.

Many chapters were originally published in *Cook's Log*, the quarterly journal of the Captain Cook Society. They still read as separate pieces, with a good deal of repetition. The level of minutiae can be overwhelming at times.

Still, there is lots to appreciate.

Cook's description of sailing in the pack ice, for instance, is vivid:

*...the wind northerly and a strong gale attended with a thick fog Sleet and Snow which froze to the Rigging as it fell and decorated the whole with icicles. Our ropes were like wires, Sails like board or plates of Metal and the Shivers froze fast in the blocks so that it required our utmost effort to get a Top-sail down and up; the cold so intense as hardly to be endured, the whole Sea in a manner covered with ice, a hard gale and a thick fog: under all these unfavourable circumstances it was natural for me to think of returning more to the North, seeing there was no probability of finding land here nor the possibility of get[ting] further to the South... [Journal, 24 December 1773]*

Hamilton has copiously enriched his text with quotes not only from Cook's multiple logbooks and journals, but also from those of more than a dozen of the officers and scientists who accompanied him.

These personal writings can offer fascinating glimpses beyond the official record.

Midshipman John Elliott, for example, reported that after the second Circle crossing, *Resolution's* officers gave their skipper broad hints that provisions were running low and that it might be time to head north. Cook, however, "only smiled and said nothing, for he was close and secret in his intentions at all times."

While the book's number of typos is very small – an increasingly rare occurrence in American publishing – errata are unfortunately less rare.

Chapter 16, "Antarctica and Sub-Antarctic Islands after Cook," is most problematic, a result of Hamilton's impressive knowledge of Cook, but not of Antarctica. "All parts of whales and seals were used in some manner," he writes on p234, when in fact the waste of all but the blubber was, sadly, widespread. Sperm oil (p234) is produced from the entirety of sperm whales' blubber, not just their heads. Leskov and Visokoi – not Lysol and Vasuki – are South Sandwich Islands, while Fabien von Bellinghausen's ships were *Vostok* and *Mirnyy*, not *Vostro* and *Marni*, and James Weddell's ships were *Jane* and *Beaufoy*, not *Beauvoir* (all p236).

The Arch of Kerguelen is not "a short distance from Christmas Harbour" (p238), but alongside it. Capt. Scott set out not from the Ross Ice Shelf (p240), as Amundsen did, but from Ross Island. His companion on the trek to the South Pole, Edward Wilson, died on March 29, not Jan. 17 (p245). *Sastrugi* (not *sasturgi*, p243) are snow ridges formed by prevailing winds. Shackleton's *Nimrod* expedition turned back 97.5 geographical miles from the South Pole, not 112 miles (p247) from it. His *Endurance* expedition members on Elephant Island inverted not "two of the ships" (!), but rather their boats, for shelter (p248).

And so on.

A few errors are more serious: Cook's Farthest South was not 70°10'S, 106°45'W, as Hamilton has it in chapter 9's epigraph, but in fact 71°10'S, 106°54'W as he states cor-



rectly on p134. The compatriots of French explorer Yves Kerguelen landed on his namesake island at Baie du Lion Marin, on the southwest coast at 49°43'S, 68°55'E, not on the island's northernmost tip as described on p190 and shown on a map on p194.

Other mistakes appear to have come straight from the Web. "Growlers," Hamilton claims, are smaller pieces of ice so-called "because of the noise they make as air escapes from them." Actually, air escaping from ice in seawater "crackles," "pops," "hisses," and "fizzes." It does not growl. A more likely explanation for the origin of "growler" is the sound one makes as it scrapes along a vessel's steel hull.

Interestingly, for all of the wonderful quotes Hamilton includes from the diaries of Cook and his colleagues, one of the passages most often associated with Cook and Antarctica is omitted. It is, however, reproduced in many books about the Seventh Continent – and certainly appears in a "daily bulletin" during nearly every Antarctic tourist cruise.

In February 1775, at the end of his second voyage's Southern Ocean odyssey, Cook allowed himself a somewhat boastful and ever-so-slightly bitter-sounding rumination:

*...Lands doomed by nature to everlasting frigidness and never once to feel the warmth of the Suns rays whose horrible and savage aspect I have no words to describe; such are the lands we have discovered, what may we expect those to be which lie more to the South, for we may reasonably suppose that we have seen the best as lying most to the North, whoever has resolution and perseverance to clear up this point by proceeding farther than I have done, I shall not envy him the honour of the discovery but I will be bold to say that the world will not be benefited by it.*

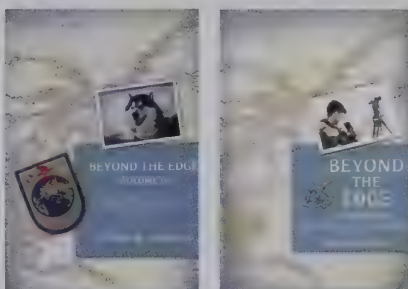
—p646, *The Journal of Captain James Cook, Vol. II*, ed. J.C. Beaglehole. (London: The Hakluyt Society, 1961)

So convincing were his pessimistic sentiments that Cook discouraged other explorers from seeking the great southern continent for decades afterward.

But Cook was mistaken.

As he recorded in his published account his observations of large numbers of seals and whales, others more commercially minded took notice. Soon the Southern Ocean was swarming with sealers and whalers from Britain, the Cape Colony, France, Tasmania, New South Wales, New Zealand and, of course, the United States.

The world was about to benefit greatly from the discovery of Antarctica, as it does to this very day.



### **Beyond the Edge (Volume II): Accounts of Historic, Significant, and Little-Known Expeditions on the Greenland Ice Cap**

By Gerald W. Johnson

Minneapolis: Mill City Press, 2016; 162 pp and

### **Beyond the Edge (Volume III): Historic Stories of Polar Navigation**

By Gerald W. Johnson

Minneapolis: Thule Publishing, 2020; 128 pp

### **Reviewed by Jeff Rubin**

Gerald W. Johnson, a surveyor and cartographer as well as emeritus professor of civil engineering at the University of Minnesota, made seven expeditions to the Arctic, including Blue Trek (Greenland Ice Cap traverse) of 1967, Project Nord (mapping in northern Greenland) of 1968-1969 and LOREX (Lomonosov Ridge Expedition) of 1979.

In these two volumes, Johnson shares his interest in the Far North via excerpts

from reports and books of Arctic expeditions. The first volume in the "Beyond the Edge" trilogy, 2010's *The Search for Ultima Thule, the Northernmost Land on Earth*, was reviewed by John Splettstoesser in the July 2011 *Polar Times*.

Of the two most recent books, Volume II is the better. Hundreds of expeditions have ventured onto or across the Greenland ice sheet, 2-3 km thick and covering 1.7 million km<sup>2</sup>, the second-largest body of ice in the world after Antarctica. Johnson has selected just 11 expeditions "by boot, ski, paw, tracked vehicle and aircraft" to excerpt. All are first-hand accounts, two are told for the first time and one is translated into English for the first time. Authors include J.A. Jensen, A.E. Norden-skiold, Fridtjof Nansen, Eivind Astrup, Peter Freuchen, J.P. Koch, Lauge Koch and Will Steger, along with modern expeditions Northice, Camp Century, Lead Dog and Blue Trek.

These accounts together give readers a sense of the challenges of travel on the ice sheet, including not only the cold and wind but also a travelling surface complicated by sastrugi, meltwater, cryokonite cavities melted by wind-blown dust absorbing solar radiation, and the curious phenomenon known as 'sun-smoke,' or dry fog.

We learn tricks such as coating sledge runners with long strips of walrus hide, then pouring water over them and allowing it to freeze. With this layer of lubricating ice, the sledge becomes "almost as easy to shove as a baby carriage," Freuchen reveals. Steger, meanwhile, shares his thoughts on managing sled dogs, developed over decades and thousands of kilometers of High Arctic dogsledding.

Food, understandably, plays an important role in morale on the stimulus-poor ice sheet, and we learn of such culinary delights as frozen musk-ox milk and the contents of a musk-ox stomach, "which tastes like a sour salad." Deprived of chewing tobacco, some expedition members gnawed on tarred rope instead – "a viler taste have I rarely known," reported one.

Still, as Nansen wrote: "...when rations were served round, and the little candle-stump lighted that we might see to eat, then rose our happiness to its zenith... Indeed I do not know many hours in my life

on which I look back with greater pleasure than on these."

Volume III is most interesting for its final three chapters on Blue Trek, Project Nord and LOREX. Project Nord recalculated the

area of northern Greenland, adding 8575 km<sup>2</sup>, nearly the size of Puerto Rico.

For more information, please visit: [www.exploringthearctic.com](http://www.exploringthearctic.com).

## ADDITIONAL READING...

### Many Norths: Spatial Practice in a Polar Territory

Authors: Lola Sheppard and Mason White  
Lateral Office/Actar Publishers, 2017  
472 pages, full colour, hard-cover



*Many Norths: Spatial Practice in a Polar Territory* charts the unique spatial realities of Canada's Arctic region, an immense territory populated with small, dispersed communities. The region has undergone dramatic transformations in the name of sovereignty, aboriginal affairs management, resources, and trade, among others. For most of the Arctic's modern history, architecture, infrastructure, and settlements have been the tools of colonialism. Today, tradition and modernity are intertwined. Northerners have demonstrated remarkable adaptation and resilience as powerful climatic, social, and economic pressures collide. This unprecedented book documents – through the themes of urbanism, architecture, mobility, monitoring, and resources – the multiplicity of norths that appear, and the spatial practices employed to negotiate it. Using innovative drawings, maps, timelines, as well as

essays and interviews, *Many Norths* reveals a distinct northern vernacular.

*Many Norths* is organized into five themes – urbanism, architecture, mobility, monitoring, and resources. It contains 30 analytical case studies of spatial practices, 15 interviews with northerners and northern experts, five illustrated timelines, and six in-depth essays. The book is supplemented with over 250 photographs and original drawings.

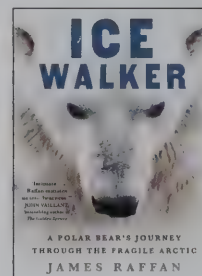
### Ice Walker: A Polar Bear's Journey through the Fragile Arctic

By James Raffan  
Publisher: Simon & Schuster – October 2020

From bestselling author James Raffan comes an enlightening and original story about a polar bear's precarious existence in the changing Arctic.

From the top of the world, Hudson Bay looks like an enormous paw print on the torso of the continent, and through a vast network of lakes and rivers, this bay connects to oceans across the globe. Here, at the heart of everything, walks Nanurjuk, or Nanu, one polar bear among the six thousand that traverse the 1.23 million square kilometers of ice and snow covering the bay.

For millennia, Nanu's ancestors have roamed this great expanse, living, evolving, and surviving alongside human beings in one of the most challenging and unforgiving habitats on earth. But that world is changing. In the Arctic's lands and waters, oil has been extracted – and spilled. As global temperatures have risen, the sea ice that Nanu and her young need to hunt



seal and fish has melted, forcing them to wait on land where the delicate balance between them and their two-legged neighbors has now shifted

This is the icescape that author and geographer James Raffan invites us to inhabit in *Ice Walker*. In precise and provocative prose, he brings readers inside Nanu's world as she treks uncertainly around the heart of Hudson Bay, searching for nourishment for the children that grow inside her. She stops at nothing to protect her cubs from the dangers she can see – other bears, wolves, whales, human beings—and those she cannot.

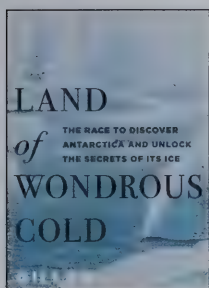
By focusing his lens on this bear family, Raffan closes the gap between humans and bears, showing us how, like the water of the Hudson Bay, our existence – and our future – is tied to Nanu's. He asks us to consider what might be done about this fragile world before it is gone for good. Masterful, vivid, and haunting, *Ice Walker* is an utterly unique piece of creative nonfiction and a deeply affecting call to action.

### Land of Wondrous Cold: The Race to Discover Antarctica and Unlock the Secrets of Its Ice

By Gillen D'Arcy Wood  
Publisher: Princeton University Press – March 3, 2020

A gripping history of the polar continent, from the great discoveries of the nineteenth century to modern scientific breakthroughs.





From bestselling author James Raffan comes an enlightening and original story about a polar bear's precarious existence in the changing Arctic.

Antarctica, the ice kingdom hosting the South Pole, looms large in the human imagination. The secrets of this vast frozen desert have long tempted explorers, but its brutal climate and glacial shores notoriously resist human intrusion. *Land of Wondrous Cold* tells a gripping story of the pioneering nineteenth-century voyages, when British, French, and American commanders raced to penetrate Antarctica's glacial rim for unknown lands beyond. These intrepid Victorian explorers—James Ross, Dumont D'Urville, and Charles Wilkes—laid the foundation for our current understanding of *Terra Australis Incognita*.

Today, the white continent poses new challenges, as scientists race to uncover Earth's climate history, which is recorded in the south polar ice and ocean floor, and to monitor the increasing instability of the Antarctic ice cap, which threatens to inundate coastal cities worldwide. Interweaving the breakthrough research of the modern Ocean Drilling Program with the dramatic discovery tales of their Victorian forerunners, Gillen D'Arcy Wood describes Antarctica's role in a planetary drama of plate tectonics, climate change, and species evolution stretching back more than thirty million years. An original, multifaceted portrait of the polar continent emerges, illuminating our profound connection to Antarctica in its past, present, and future incarnations.

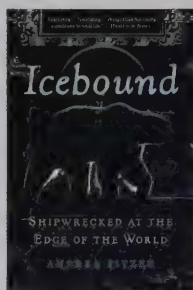
A deep-time history of monumental scale, *Land of Wondrous Cold* brings the remotest of worlds within close reach—an Antarctica vital to both planetary history and human fortunes.

## Icebound: Shipwrecked at the Edge of the World

By Andrea Pitzer

Publisher: Scribner—January 12, 2021

In the bestselling tradition of Hampton Sides's *In the Kingdom of Ice*, a riveting and cinematic tale of Dutch polar explorer William Barents and his three harrowing Arctic expeditions—the last of which resulted in a relentlessly challenging year-long fight for survival.



The human story has always been one of perseverance—often against remarkable odds. The most astonishing survival tale of all might be that of 16th-century Dutch explorer William Barents and his crew of sixteen, who ventured farther north than any Europeans before and, on their third polar exploration, lost their ship off the frozen coast of Nova Zembla to unforgiving ice. The men would spend the next year fighting off ravenous polar bears, gnawing hunger, and endless winter.

In *Icebound*, Andrea Pitzer masterfully combines a gripping tale of survival with a sweeping history of the great Age of Exploration—a time of hope, adventure, and seemingly unlimited geographic frontiers. At the story's center is William Barents, one of the 16th century's greatest navigators whose larger-than-life ambitions and obsessive quest to chart a path through the deepest, most remote regions of the Arctic ended in both tragedy and glory. Journalist Pitzer did extensive research, learning how to use four-hundred-year-old navigation equipment, setting out on three Arctic expeditions to retrace Barents's steps, and visiting replicas of Barents's ship and cabin.

"A visceral, thrilling account full of tantalizing surprises" (Andrea Barrett, author of *The Voyage of the Narwhal*), Pitzer's reenactment of Barents's ill-fated journey

shows us how the human body can function at twenty degrees below, the history of mutiny, the art of celestial navigation, and the intricacies of building shelters. But above all, it gives us a first-hand glimpse into the true nature of human courage.

## AUDIOBOOK

### Labyrinth of Ice: The Triumphant and Tragic Greely Polar Expedition

Author: Buddy Levy, Narrator: Will Damron

Publisher: Macmillan Audio—2019

Length: 13 hrs and 13 mins



Based on the author's exhaustive research, *Labyrinth of Ice* tells the true story of the heroic lives and deaths of these voyagers

hell-bent on fame and fortune—at any cost—and how their journey changed the world. The Greely Expedition was undoubtedly one of the most agonizing adventures in the annals of polar exploration.

"Listen to this if you want to hear a narrator at the top of his game recount a fascinating—and at times disturbing—true story of adventure, disaster, discovery, cannibalism, and more. Will Damron makes Levy's fascinating account of the Greely (Polar) Expedition come to life.... This is a harrowing adventure story and a great listen." (*AudioFile Magazine*)

**PLEASE NOTE:** When you purchase this title, the accompanying PDF will be available in your Audible Library along with the audio.

For a free 5-minute audio sample of a reading of the book, scan this QR code:

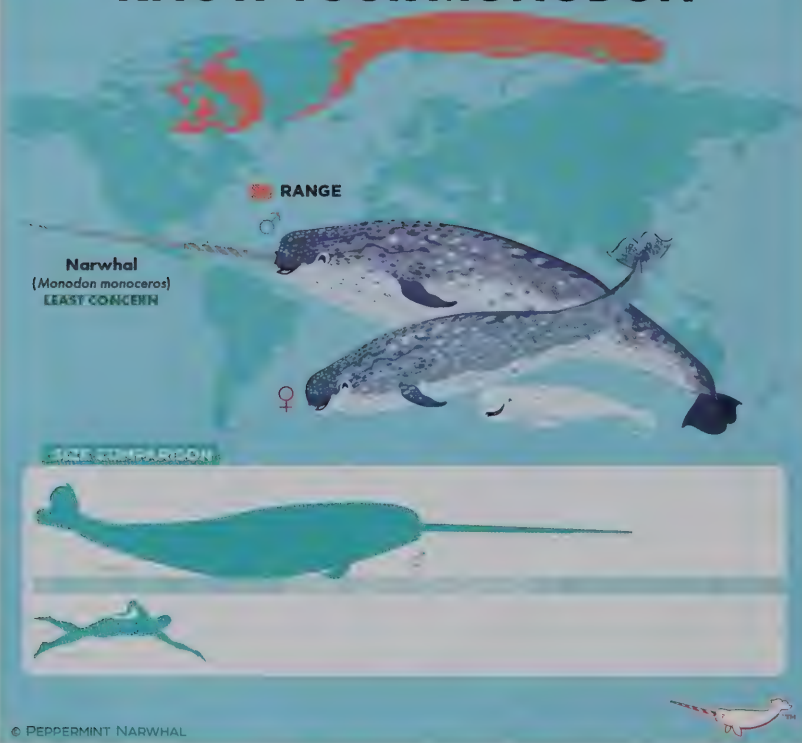




# bergie bits

For the not yet ready for prime time polar explorers and scientists to be

## KNOW YOUR MONODON



THE POLAR TIMES would like to thank Brian + Becky Masuga for granting us permission to publish one of their "conservation through creativity" posters. We invite our readers to visit their website at [www.peppermintnarwhal.com](http://www.peppermintnarwhal.com) or to scan the QR code. You won't find penguins any more endearing than the waddle on their infographic.



## FUN POLAR FACTS

- › Beluga whale skin is amazingly thick. Not only does its density help keep Belugas warm in icy waters, but their skin was also used in the first prototype of the bulletproof vest!
- › 12 members of the 2004/2005 Antarctic Search for Meteorites [ANS-MET] expedition in the Transantarctic Mountains recovered 1,230 meteorites. These included over 130 kilograms (290 lb) of pallasite meteorites, one of which, at a little over 30 kilograms (66 lb), is the largest yet found in Antarctica!
- › Snow Fleas possess a special protein that protects them from freezing. This "antifreeze" is being studied for properties that may lengthen the shelf life of human organs for transplantation.

## Iceberger

Draw an iceberg and see how it will float. (Inspired by a tweet by @GlacialMeg)

Go ahead! Try it! Scan the QR code or visit here:  
<https://joshdata.me/iceberger.html>



ICEBERGS ARE LESS DENSE than water, so they always float with about 10% of their mass above the water's surface. But which way up? Its three-dimensional distribution of mass and its relative density compared to the water are significant factors that are approximated here. Created by software developer and civic technologist, Joshua Tauberer, Ph.D. the ICEBERGER interactive works on computers, tablets and smartphones.





**NEVER ALONE**, is a puzzle-platformer adventure video game, developed by Upper One Games, and published by E-Line Media. It is based on the traditional Iñupiaq tale, “Kunuksaayuka,” which was first recorded by master storyteller Robert Nasruk Cleveland in his collection *Stories of the Black River People*. Swapping between an Iñupiaq girl named Nuna, and her Arctic Fox companion, the player completes puzzles in a story that spans eight chapters. The game was the result of a partnership between the Cook Inlet Tribal Council and E-Line Media. It is one of a growing number of video games produced by indigenous peoples.



**The US Postal Service chooses Tlingit artist’s design for a 2021 postage stamp** Tlingit and Athabascan artist Rico Lanáat’ Worl designed a new stamp for the U.S. Postal Service, titled “Raven Story,” to be released in 2021. This stamp depicts one of many stories about Raven, a figure of great significance to the Indigenous peoples of the Northwest Coast. Among the cultures of the region, Raven plays an essential role in many traditional tales, including stories about the creation of the world.



**A Very Short Guide to Union Glacier Camp** As described by Temujin Doran, the film’s director, producer and videographer extraordinaire: “Union Glacier camp is a seasonal, remote field camp in West Antarctica. It is one of my favourite places in the world, due largely to the wonderful people who run and pass through the camp.”



**PBS NOVA: Polar Extremes** This is the trailer to a two-hour documentary, in which renowned paleontologist Kirk Johnson takes us on an epic adventure through time at the polar extremes of our planet. Following a trail of strange fossils found in all the wrong places—beech trees in Antarctica, hippo-like mammals in the Arctic—Johnson uncovers the bizarre history of the poles.



**Arctic Fox Kit vs GoPro Camera** A smile-inducing short clip of a curious young Arctic Fox trying to engage with a GoPro camera; recorded in northern Greenland.



**PBS Terra: Antarctic Extremes – What Do You Eat in Antarctica?** If you’re a penguin or other seabird in Antarctica, there’s plenty of fish (and some seal placenta) to go around. But what do the people eat?



## WHERE HAS THE ARCTIC GONE?

It was extraordinarily warm this past summer across the Northern Hemisphere, even near the North Pole. Where have the Arctic, the ice, the archetypal polar landscapes gone? Here, Florian Ledoux, whose magnificent photographs graced the pages of the previous issue of our journal, shares thoughts about his travels to the Svalbard archipelago during the Covid-19 crisis, when coincidentally the highest ever temperature in the archipelago had officially been recorded.

### Two Expeditions to Svalbard During the Covid-19 Crisis

by *Florian Ledoux*

AT THE END OF MAY (2020), I was standing at the top of a snow-covered mountain rising out of the sea in Tromsø where I am based. As it had for most of my fellow photographers, the global pandemic cancelled all of my trips for the year. But at that moment, my summer plans had suddenly been recast when I met my future friend and sailing companion. Together, we decided to set off on a last-minute sailing expedition from Tromsø (Norway) to Longyearbyen (Svalbard), where I would disembark.

Since we are both residents of Norway, we were not restricted from traveling to Svalbard (which is part of the Kingdom of Norway) even though the archipelago had been closed to the rest of the world. So, we started planning. A few weeks of work on the boat – painting, repairing, preparing and loading of a month's worth of food, and we would be ready to depart for Svalbard by early July.

I was nervous as the weather was unfavorable for the crossing. We would need to avoid all of the lows in the Barents Sea around us. But at the same time, I was

Aerial image of a walrus colony in northern Svalbard



thoroughly excited about the opportunity to visit Svalbard once again, though this time to have it almost completely to myself. Svalbard can get quite busy during peak tourist season, so I was eager to rediscover this truly special place, but with hardly anyone around. These rare circumstances would make my photographs even more meaningful.

After nearly a full month of sailing, having faced difficult weather conditions, more than 1,500 km covered, incredible encounters with pods of hundreds of belugas, whales, Arctic Foxes and other animals, and exploring the southern regions of the archipelago, we finally reached Longyearbyen, a small town on Spitsbergen – Svalbard's largest island.

It was in the middle of this summer season when the air temperature suddenly rose to 23.0 °C (73.4°F) due to an unusual flow of hot air from Siberia. On Saturday, July 25, 2020, not only was Longyearbyen the hottest place in all of Norway, but the temperature was the highest ever recorded since meteorological record-keeping began. And this occurred only 1,050 km (650 miles) from the Geographic North Pole!

The average air temperature in Svalbard has increased by 3 ° to 5 °C over the past five decades. In recent years, there have also been many episodes

of heavy rains during the winter. These changes have profound impacts on all ecosystems of this Arctic region as everything is directly linked to the ice. All observed glaciers are shrinking, and satellite models and measurements confirm that Svalbard as a whole is losing ice mass. All glaciers are shrinking, and satellite measurements confirm that Svalbard experienced 7% of glacier area reduction between the 1960s and the 2000s. The aerial photographs I took farther northeast during the second expedition clearly show significant summer melt.

### New Hope for the Atlantic Walrus

The second expedition during the summer of 2020, allowed me to document a large North Atlantic mammal – the walrus – from a new perspective. The first time I encountered walrus, I became fascinated by them. They may look hideous, they smell bad, and you might think they are lazy. But they also have many intriguing habits and can be quite endearing when you observe them more closely.

Walrus were once extremely abundant in Svalbard, but three and a half centuries of unregulated commercial harvest for their ivory tusks brought them to the brink of extinction. In 1952, at a time



when there were only one hundred animals left on the archipelago, walrus were finally placed under protection.

After nearly seven decades under Norwegian protection policies, the population in Svalbard is still relatively small compared to past numbers. Though they remain on the Red List as a threatened species, in recent years, the number of walrus has been increasing. A study in 2006, showed that the population had recovered to 2,629 individuals. The latest Norwegian Polar Institute study done in 2018, estimated the number of walrus in Svalbard to be approximately 5,500.

It is difficult to estimate the number of walrus from the ground when we encounter them on a haul-out site. The tendency is to underestimate. However, the aerial images I was able to capture during this expedition allowed researchers to accurately calculate how many walrus there were in just a single colony. Additionally, we observed walrus on haul-out sites where they had not been seen in decades. This is clear evidence that when nature is protected, it can be resilient, and proves that many ecosystems are capable of recovery.



**Clockwise from top right:** Aerial view of a polar bear resting on vegetation at the bottom of a bird cliff in Svalbard.

Aerial view of a waterfall from the Austfonna ice cap during summer melt.

Aerial view of moulin created by summer meltwater on the Austfonna ice cap.





The vanishing north: an iceberg will soon be released to  
the spring melt in the bay of Qaanaaq, northern Greenland  
© Sebastian Copeland

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